I/O Wiring and Specifications

In This Chapter...

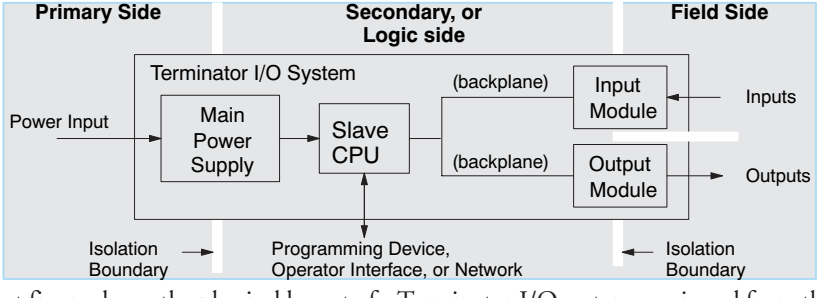
I/O Wiring Strategies 3–2
I/O Modules Position, Wiring and Specifications 3–14
I/O Module Hot Swap Feature 3–21
Calculating the Power Budget 3–22
I/O Specification Terms 3–26
Module Specifications Begin Here 3–28

I/O Wiring Strategies

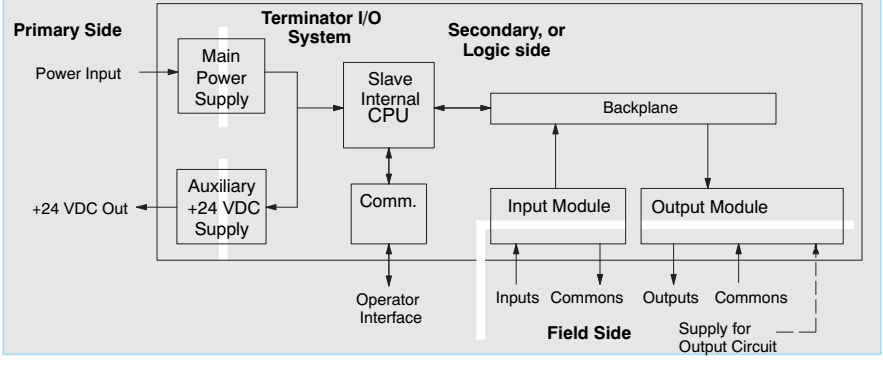
Terminator I/O System Isolation Boundaries

The Terminator I/O system is very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application. This will help to lower system cost, wiring errors, and avoid safety problems.

Terminator I/O system circuitry is divided into three main regions separated by isolation boundaries, shown in the drawing below. Electrical isolation provides safety, so that a fault in one area does not damage another. A transformer in the power supply provides magnetic isolation between the primary and secondary sides. Opto-couplers provide optical isolation in Input and Output circuits. This isolates logic circuitry from the field side, where factory machinery connects. Note the discrete inputs are isolated from the discrete outputs, because each is isolated from the logic side. Isolation boundaries protect the operator interface (and the operator) from power input faults or field wiring faults. When wiring a Terminator I/O system, it is extremely important to avoid making external connections that connect logic side circuits to any other.



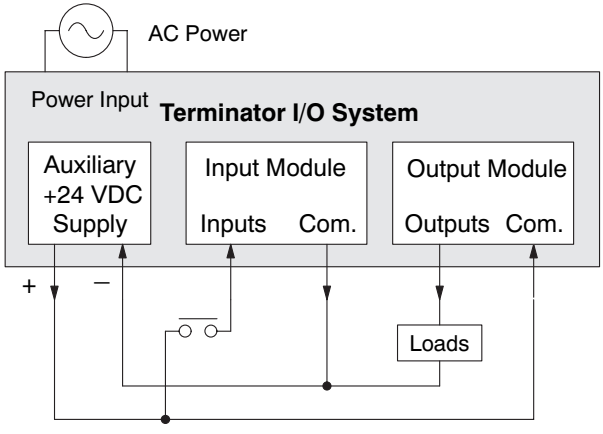
The next figure shows the physical layout of a Terminator I/O system, as viewed from the front. In addition to the basic circuits covered above, AC-powered bases include an auxiliary +24 VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits, it can power input and/or output circuits!



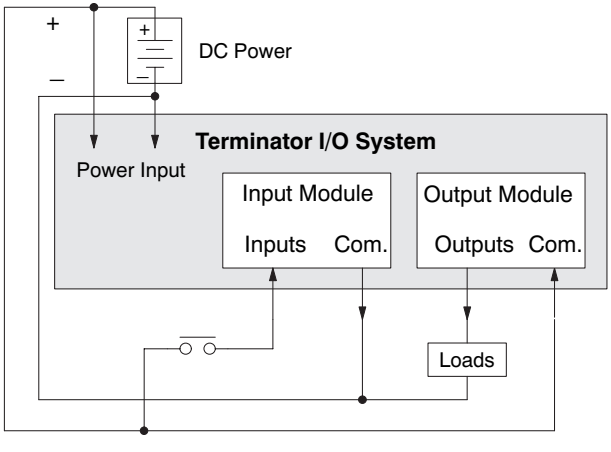
In some cases, using the built-in auxiliary +24 VDC supply can result in a cost savings for your control system. It can power combined loads up to 500mA if power budget allows. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24 VDC auxiliary supply.

Powering I/O Circuits with the Auxiliary Supply

All AC power supplies feature an internal auxiliary supply. If input devices AND output loads need +24 VDC power, the auxiliary supply may be able to power both circuits as shown in the following diagram.



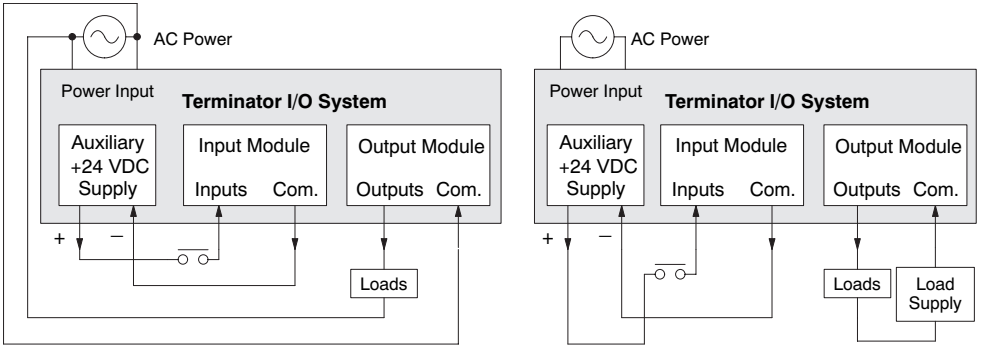
DC-powered units are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this type of application, all input devices and output loads typically use the same DC power source. Typical wiring for DC-powered applications is shown in the following diagram.



Powering I/O Circuits Using Separate Supplies

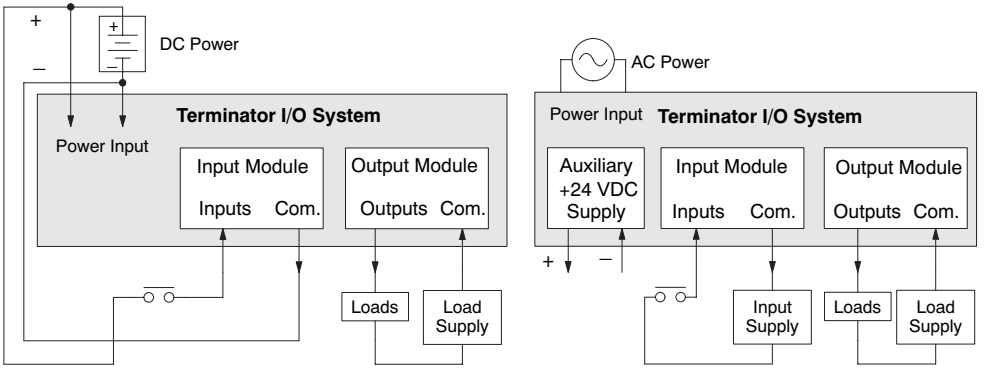
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then safety reasons also require isolation from high-energy output circuits. It is most convenient if the loads can use the same power source as the Terminator I/O system, and the input sensors can use the auxiliary supply, as shown to the left in the figure below.

If the loads cannot be powered from the system supply, then a separate supply must be used as shown to the right in the figure below.



Some applications will use the external power source to also power the input circuit. This typically occurs on DC-powered systems, as shown in the drawing below to the left. The inputs share the system power source supply, while the outputs have their own separate supply.

A worse-case scenario, from a cost and complexity view-point, is an application which requires separate power sources for the Terminator I/O system, input devices, and output loads. The example wiring diagram below on the right shows how this can work, but also the auxiliary supply output is an unused resource. You will want to avoid this situation if possible.



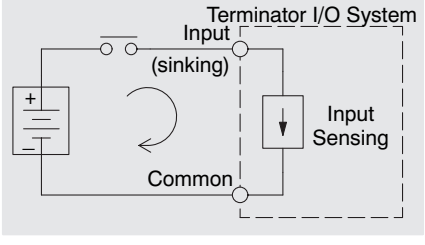
Sinking / Sourcing Concepts

Before going further in the study of wiring strategies, you must have a solid understanding of "*sinking*" and "*sourcing*" concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring your success in installation. First the following short definitions are provided, followed by practical applications.

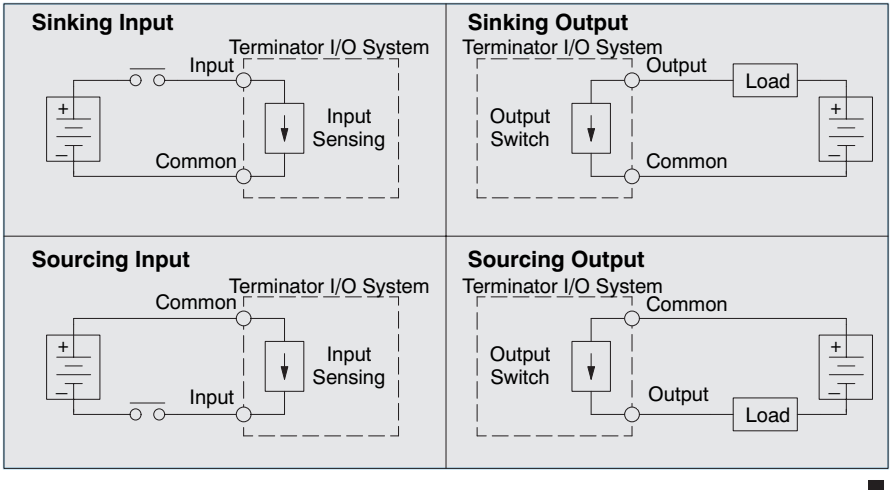
Sinking = provides a path to supply ground (-)
Sourcing = provides a path to supply source (+)

First you will notice these are only associated with DC circuits and not AC, because of the reference to (+) and (-) polarities. Therefore, sinking and sourcing terminology only applies to DC input and output circuits. Input and output points that are sinking or sourcing only can conduct current in only one direction. This means it is possible to connect the external supply and field device to the I/O point with current trying to flow in the wrong direction, and the circuit will not operate. However, you can successfully connect the supply and field device every time by understanding "sourcing" and "sinking".

For example, the figure to the right depicts a "sinking" input. To properly connect the external supply, you will have to connect it so the input provides a path to ground (-). Start at the Terminator I/O system input terminal, follow through the input sensing circuit, exit at the common terminal, and connect the supply (-) to the common terminal. By adding the switch, between the supply (+) and the input, the circuit has been completed . Current flows in the direction of the arrow when the switch is closed.

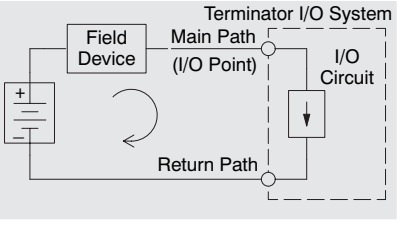


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.

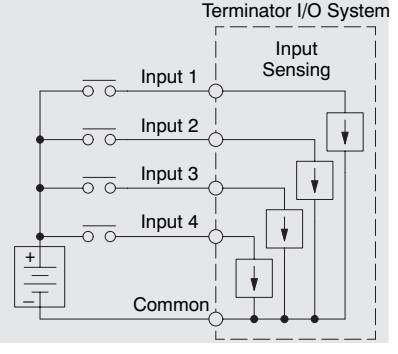


I/O "Common" Terminal Concepts

In order for an I/O circuit to operate, current must enter at one terminal and exit at another. Therefore, at least two terminals are associated with every I/O point. In the figure to the right, the Input or Output terminal is the main path for the current. One additional terminal must provide the return path to the power supply..

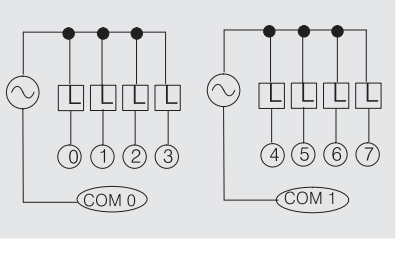


If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points are in groups which share the return path (called commons). The figure to the right shows a group (or bank) of 4 input points which share a common return path. In this way, the four inputs require only five terminals instead of eight.

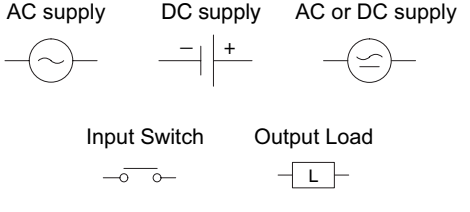


NOTE: *In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.*

Most Terminator I/O input and output modules group their I/O points into banks that share a common return path. The best indication of I/O common grouping is on the wiring label, such as the one shown to the right. The miniature schematic shows two banks of circuits with four output points in each. The common terminal for each is labeled COM 0 and COM 1, respectively.



In this wiring label example, the positive terminal of a DC supply connects to the common terminals. Some symbols you will see on the wiring labels, and their meanings are:

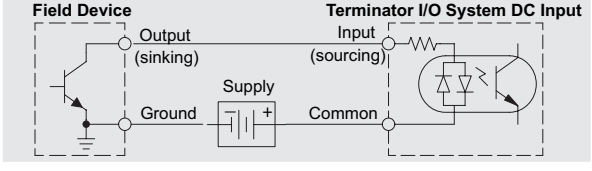


Connecting DC I/O to Solid State Field Devices

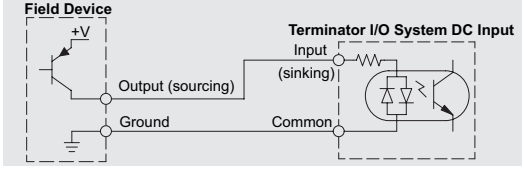
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting two devices in a series DC circuit, one must be wired as sourcing and the other as sinking:*

Solid State Input Sensors

Terminator I/O DC input modules are flexible because they detect current flow in either direction, so they can be wired as either sourcing or sinking. In the following circuit, a field device has an open-collector NPN transistor output. It sinks current from the input point, which sources current. The power supply can be the +24 auxiliary supply or another supply (+12 VDC or +24 VDC), as long as the input specifications are met.



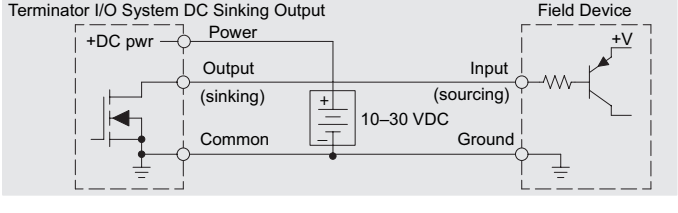
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.



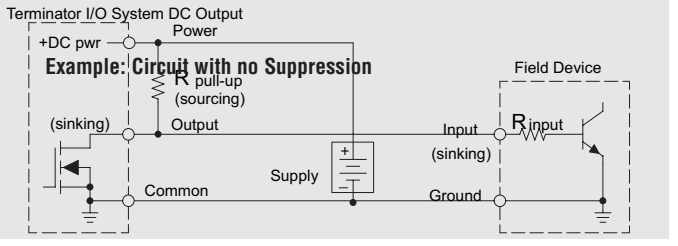
Solid State Ouput Loads

Sometimes an application requires connecting an output point to a solid state input on a device. This type of connection is usually made to carry a low-level control signal, not to send DC power to an actuator.

Several of the Terminator I/O DC output modules are the sinking type. This means that each DC output provides a path to ground when it is energized. In the following circuit, the output point sinks current to the output common when energized. It is connected to a sourcing input of a field device input.



In the next example a sinking DC output point is connected to the sinking input of a field device. This is a little tricky, because both the Terminator I/O system output and field device input are sinking type. Since the circuit must have one sourcing and one sinking device, a sourcing capability needs to be added to the Terminator I/O system output by using a pull-up resistor. In the circuit below, a $R_{pull\text{-}up}$ is connected from the output to the DC output circuit power input.



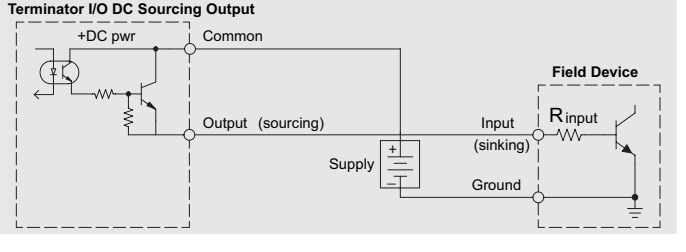
***NOTE 1**: DO NOT attempt to drive a heavy load (>25 mA) with this pull-up method.*
***NOTE 2**: Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the Terminator I/O system output is OFF, from a ladder logic point-of-view. Your ladder program must comprehend this and generate an inverted output. Or, you may choose to cancel the effect of the inversion elsewhere, such as in the field device.*

It is important to choose the correct value of R pull-up. In order to do so, you need to know the nominal input current to the field device (I input) when the input is energized. If this value is not known, it can be calculated as shown (a typical value is 15 mA). Then use I input and the voltage of the external supply to compute $R_{pull\text{-}up}$. Then calculate the power $P_{pull\text{-}up}$ (in watts), in order to size $R_{pull\text{-}up}$ properly.

$$I_{input} = \frac{V_{input\ (turn\text{–}on)}}{R_{input}}$$

$$R_{pull\text{-}up} = \frac{V_{supply} - 0.7}{I_{input}} - R_{input} \qquad P_{pull\text{-}up} = \frac{V_{supply}^2}{R_{pullup}}$$

Of course, the easiest way to drive a sinking input field device as shown below is to use a DC sourcing output module. The Darlington NPN stage will have about 1.5 V ON-state saturation, but this is not a problem with low-current solid-state loads.



Relay Output Guidelines

Several output modules in the Terminator I/O family feature relay outputs: T1K-08TR, T1K-16TR, and T1K-08TRS. Relays are best for the following applications:

- Loads that require higher currents than the solid-state outputs can deliver
- Cost-sensitive applications
- Some output channels need isolation from other outputs (such as when some loads require different voltages than other loads)

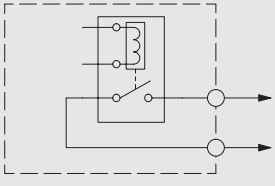
Some applications in which NOT to use relays:

- Loads that require currents under 10 mA
- Loads which must be switched at high speed or heavy duty cycle

Relay output module contacts are availabe in Form A type, or SPST (single pole, single throw) normally open.

Some relay output module's share common relay terminals, which connect to the wiper contact in each relay of the bank. Other relay modules have relays which are completely isolated from each other. In all cases, the module drives the relay coil when the corresponding output point is on.

Relay with Form A contacts



Relay Outputs - Transient Suppresion for Inductive Loads in a Control System

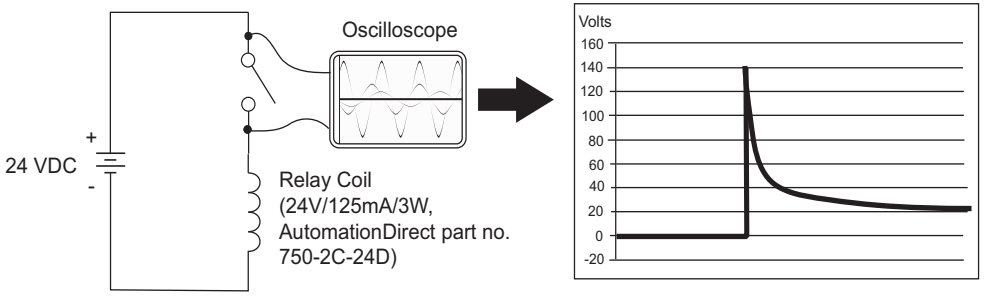
The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious errors that can afflict an installation can be traced back to a lack of transient suppression.

What is a Transient Voltage and Why is it Bad?

Inductive loads (devices with a coil) generate transient voltages as they transition from being energized to being de-energized. If not suppressed, the transient can be many times greater than the voltage applied to the coil. These transient voltages can damage PLC outputs or other electronic devices connected to the circuit, and cause unreliable operation of other electronics in the general area. Transients must be managed with suppressors for long component life and reliable operation of the control system.

This example shows a simple circuit with a small 24V/125mA/3W relay. As you can see, when the switch is opened, thereby de-energizing the coil, the transient voltage generated across the switch contacts peaks at 140V.

Example: Circuit with no Suppression



In the same circuit, replacing the relay with a larger 24V/290mA/7W relay will generate a transient voltage exceeding 800V (not shown). Transient voltages like this can cause many problems, including:

- Relay contacts driving the coil may experience arcing, which can pit the contacts and reduce the relay's lifespan.
- Solid state (transistor) outputs driving the coil can be damaged if the transient voltage exceeds the transistor's ratings. In extreme cases, complete failure of the output can occur the very first time a coil is de-energized.
- Input circuits, which might be connected to monitor the coil or the output driver, can also be damaged by the transient voltage.

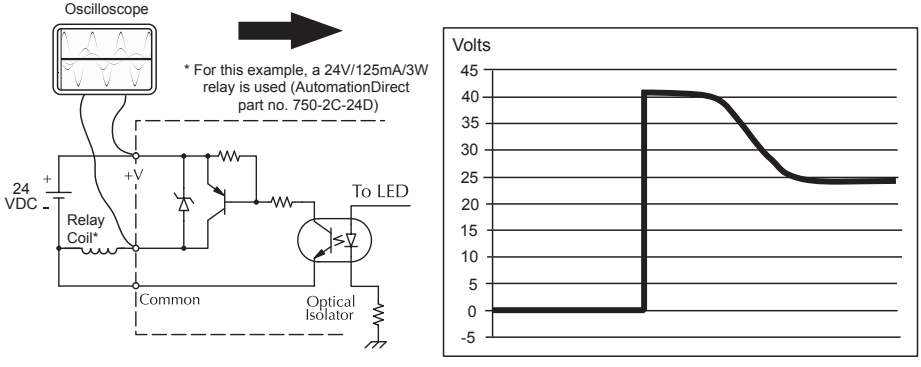
A very destructive side-effect of the arcing across relay contacts is the electromagnetic interference (EMI) it can cause. This occurs because the arcing causes a current surge, which releases RF energy. The entire length of wire between the relay contacts, the coil, and the power source carries the current surge and becomes an antenna that radiates the RF energy. It will readily couple into parallel wiring and may disrupt the PLC and other electronics in the area. This EMI can make an otherwise stable control system behave unpredictably at times.

PLC's Integrated Transient Suppressors

Although the PLC's outputs typically have integrated suppressors to protect against transients, they are not capable of handling them all. It is usually necessary to have some additional transient suppression for an inductive load.

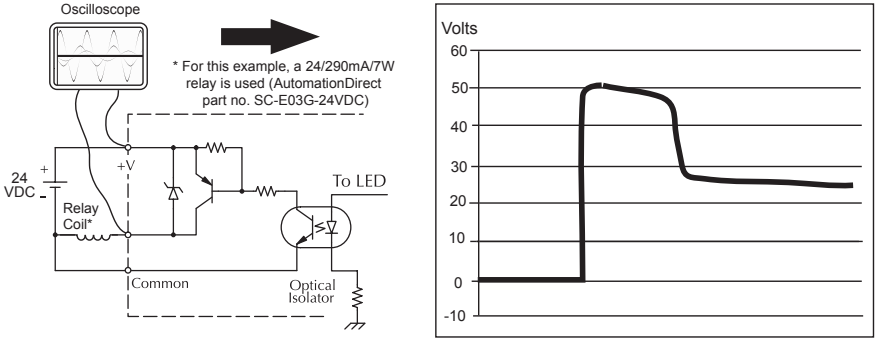
The next example uses the same 24V/125mA/3W relay used earlier. This example measures the PNP transistor output of a D0-06DD2 PLC, which incorporates an integrated Zener diode for transient suppression. Instead of the 140V peak in the first example, the transient voltage here is limited to about 40V by the Zener diode. While the PLC will probably tolerate repeated transients in this range for some time, the 40V is still beyond the module's peak output voltage rating of 30V.

Example: Small Inductive Load with Only Integrated Suppression



The next example uses the same circuit as above, but with a larger 24V/290mA/7W relay, thereby creating a larger inductive load. As you can see, the transient voltage generated is much worse, peaking at over 50V. Driving an inductive load of this size without additional transient suppression is very likely to permanently damage the PLC output.

Example: Larger Inductive Load with Only Integrated Suppression

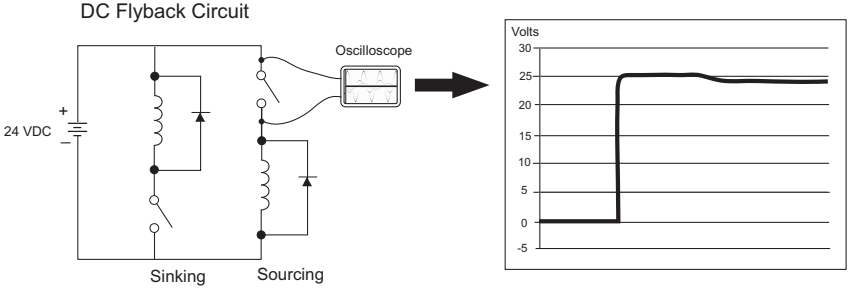


Additional transient suppression should be used in both these examples. If you are unable to measure the transients generated by the connected loads of your control system, using additional transient suppression on all inductive loads would be the safest practice.

Types of Additional Transient Protection

DC Coils:

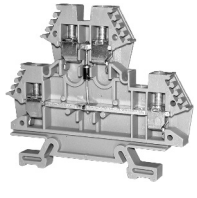
The most effective protection against transients from a DC coil is a flyback diode. A flyback diode can reduce the transient to roughly 1V over the supply voltage, as shown in this example.



Many AutomationDirect socketed relays and motor starters have add-on flyback diodes that plug or screw into the base, such as the AD-ASMD-250 protection diode module and 784-4C-SKT-1 socket module shown below. If an add-on flyback diode is not available for your inductive load, an easy way to add one is to use AutomationDirect's DN-D10DR-A diode terminal block, a 600VDC power diode mounted in a slim DIN rail housing.

AD-ASMD-250
Protection Diode Module

784-4C-SKT-1
Relay Socket

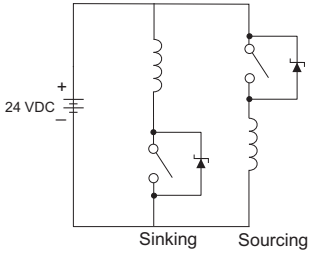


DN-D10DR-A
Diode Terminal Block

Two more common options for DC coils are Metal Oxide Varistors (MOV) or TVS diodes. These devices should be connected across the driver (PLC output) for best protection as shown below. The optimum voltage rating for the suppressor is the lowest rated voltage available that will NOT conduct at the supply voltage, while allowing a safe margin.

AutomationDirect's ZL-TSD8-24 transorb module is a good choice for 24VDC circuits. It is a bank of 8 uni-directional 30V TVS diodes. Since they are uni-directional, be sure to observe the polarity during installation. MOVs or bi-directional TVS diodes would install at the same location, but have no polarity concerns.

DC MOV or TVS Diode Circuit

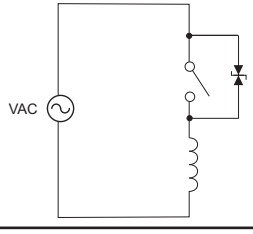


AC Coils:

Two options for AC coils are MOVs or bi-directional TVS diodes. These devices are most effective at protecting the driver from a transient voltage when connected across the driver (PLC output) but are also commonly connected across the coil. The optimum voltage rating for the suppressor is the lowest rated voltage available that will NOT conduct at the supply voltage, while allowing a safe margin.

AutomationDirect's ZL-TSD8-120 transorb module is a good choice for 120VAC circuits. It is a bank of eight bi-directional 180V TVS diodes.

AC MOV or Bi-Directional Diode Circuit



NOTE: *Manufacturers of devices with coils frequently offer MOV or TVS diode suppressors as an add-on option which mount conveniently across the coil. Before using them, carefully check the suppressor's ratings. Just because the suppressor is made specifically for that part does not mean it will reduce the transient voltages to an acceptable level.*

For example, a MOV or TVS diode rated for use on 24-48 VDC coils would need to have a high enough voltage rating to NOT conduct at 48V. That suppressor might typically start conducting at roughly 60VDC. If it were mounted across a 24V coil, transients of roughly 84V (if sinking output) or -60V (if sourcing output) could reach the PLC output. Many semiconductor PLC outputs cannot tolerate such levels.

I/O Modules Position, Wiring and Specifications

Multiple Power Supply Configuration

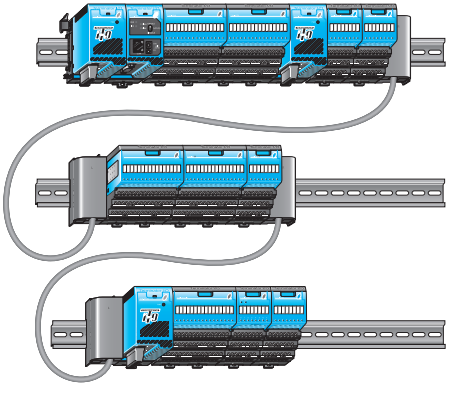
It is possible to have multiple power supplies in a single slave (node) system to meet power budget requirements. **One power supply is required in the leftmost component position followed by the base controller.** Additional power supplies should be added between I/O modules as necessary to meet power budget requirements (there are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR(-1) expansion base cable). Each power supply powers the modules to its right, but is interrupted by the next power supply. Each slave (node) system can be divided into one row of base I/O plus two rows of local expansion I/O up to a total of 16 I/O modules.

Expansion cables are available in two configurations: one that passes 24 VDC base power through and one that does not (both cables pass the 5 VDC base power). The (-1) version of the expansion cables pass 24 VDC through on an isolated wire. Any local expansion DC input modules configured for internal power (current sourcing) must either have a power supply preceeding it on the same base or, have a (-1) version cable to pass 24 VDC from a power supply on the preceeding base.

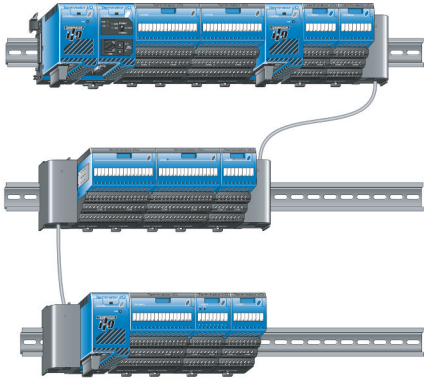
Overview of I/O Expansion Configurations

There are several expansion I/O system configurations that can be created by using the local expansion cables. There are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR-1 expansion base cable. Refer to Chapter 2 for details of the example systems shown below.

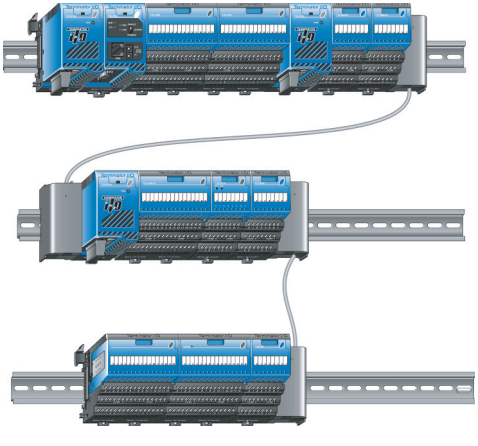
One expansion cable each;
T1K-10CBL and T1K-10CBL-1



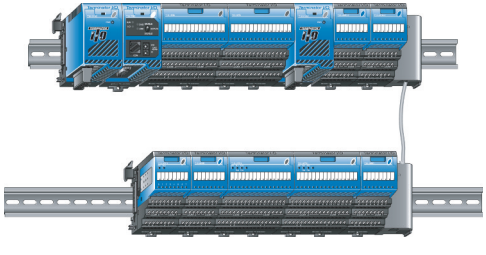
One expansion cable each;
T1K-05CBL-RR-1 and T1K-05CBL-LL



One expansion cable each;
T1K-10CBL-1 and T1K-05CBL-RR-1



T1K-05CBL-RR-1 Expansion Cable



Types of Modules Available for the Terminator System

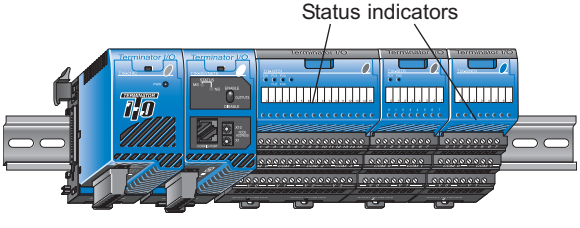
The table below lists the type of modules are available for the Terminator by category

Terminator I/O Module / Unit	Slave System
Base Controller	Only one per slave (node) system. Mount to the right of the first power supply.
Additional Power Supplies	Yes (see Note)
DC Input Modules	Yes
AC Input Modules	Yes
DC Output Modules	Yes
AC Output Modules	Yes
Relay Output Modules	Yes
Analog Modules (volt, current, temp)	Yes
CTRIO Counter I/O Modules	Yes

NOTE: *One power supply is required in the leftmost component position followed by the Base Controller. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. Each power supply powers the modules to its right, but is interrupted by the next power supply. It is not mandatory to have a power supply in the leftmost position on an expansion rack. Expansion cables are available in two configurations: one that passes 24 VDC base power through and one that does not.*

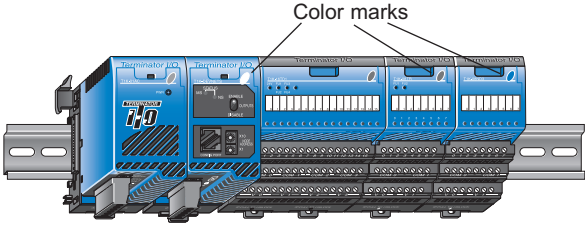
Discrete Module Status Indicators

The discrete I/O modules provide LED status indicators to show the status of the I/O points. Most of the output modules have additional LEDs to indicate a blown fuse.



Color Coding of I/O Modules

The Terminator I/O family of I/O modules have a color coding scheme to help you quickly identify the module as either a power supply, an input module or an output module. This is done through a color mark indicator located on the front of each module. The color scheme is shown in the diagram and table on the facing page.

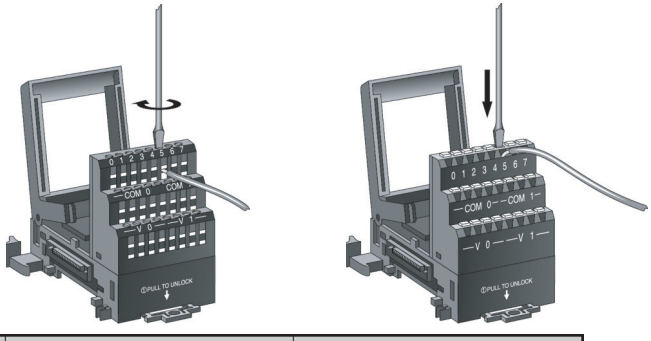


Module Type	Color Code
Power Supply	Green
Base Controller / Specialty	White
Discrete / Analog Input	Blue
Discrete / Analog Output	Red

Wiring the I/O Module Bases

There are two types of terminal bases for the Terminator I/O modules: screw clamp and spring clamp connectors. The recessed screw heads help minimize the risk of someone accidentally touching active wiring.

WARNING: For some modules, field device power may still be present on the terminal block even though the Terminator I/O system power is turned off. To minimize the risk of electrical shock, check all field device power before you remove a wire.

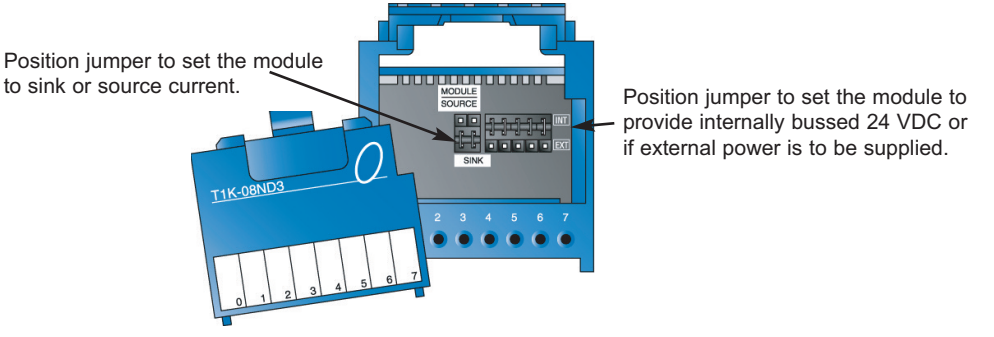


Terminal Type	Screw Type	Spring Clamp
Recommended Torque	1.77 - 3.54 lb-inch (0.2 - 0.4 Nm)	-
Recommended Screwdriver Blade Size	0.02 in. x 0.125 in. (0.5 mm x 3 mm)	push in on clamp using screwdriver blade size: (0.016 x 0.079 to 0.032 x 0.16) in. (0.4 x 2 to 0 .8 x 4) mm
Wire Gauge	solid conductor: 24 - 12 AWG stranded conductor: 24 - 12 AWG	solid conductor: 24 - 14 AWG stranded conductor: 24 - 14 AWG (Twist conductors before inserting into gate)

Selecting Internal 24 VDC Power Supply

The DC input field devices can be powered from the integrated 24 VDC power supply from the power supply bus. The T1K-08ND3 and T1K-16ND3 DC input modules have jumpers for selecting internal 24 VDC power supply available for 2 and 3-wire field devices. The analog I/O and DC output modules do not have direct access to the internal bussed 24 VDC.

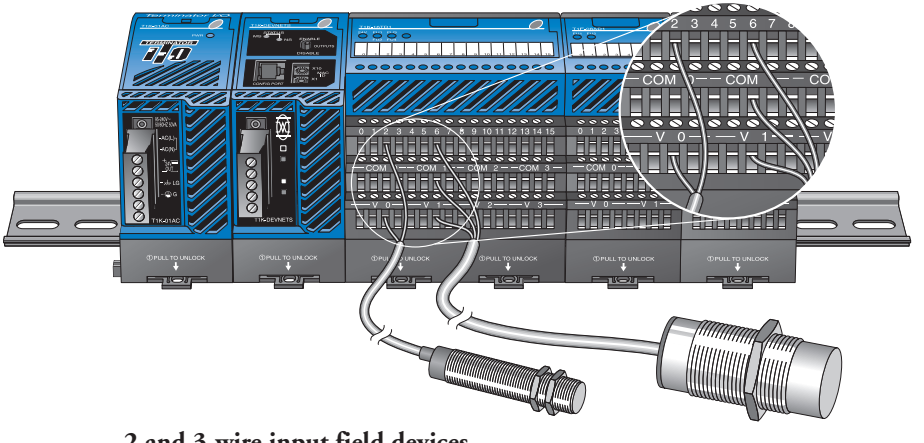
Jumpers located under top cover of T1K-08ND3 and T1K-16ND3


Position jumper to set the module to sink or source current.
MODULE SOURCE
SINK
INT
EXT
Position jumper to set the module to provide internally bussed 24 VDC or if external power is to be supplied.
T1K-08ND3
0 1 2 3 4 5 6 7
2 3 4 5 6 7

Using Internal 24 VDC Base Power

The diagram below shows DC input devices using internally bussed 24 VDC for power. If the module is set to "sink" current, +24 VDC power is supplied to the input module base "COM" terminals and 0 VDC is supplied to the module base "V" terminals. If the module is set to "source" current, +24 VDC is supplied to the input module base "V" terminals and 0 VDC is supplied to the module base "COM" terminals.

Using Internally Bussed 24 VDC (T1K-08ND3, T1K-16ND3 only)



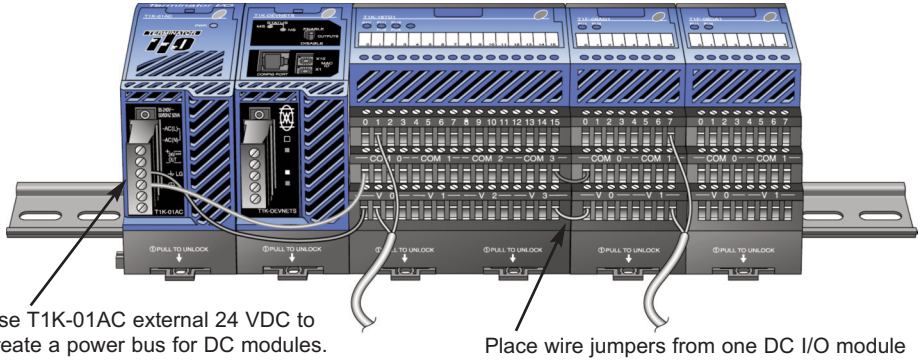
2 and 3-wire input field devices

External 24 VDC Wiring Options

DC output and analog I/O modules do not have direct access to the internally bussed 24 VDC. External user supplied 24 VDC power, or auxiliary 24 VDC from the T1K-01AC, can be applied directly to one end of the DC I/O module base terminal (V and COM) rows and jumpered across each base as needed in a system. This creates a "bus" (row) of 24 VDC and a bus of 0 VDC power. Be sure not to exceed the supply's power budget.

NOTE: *If you intend to use the I/O module Hot Swap feature, refer to the Check External 24 VDC Wiring Before Hot Swapping" section on page 3-17. The external 24 VDC wiring options below are not recommended when intending to Hot Swap DC output or analog I/O modules.*

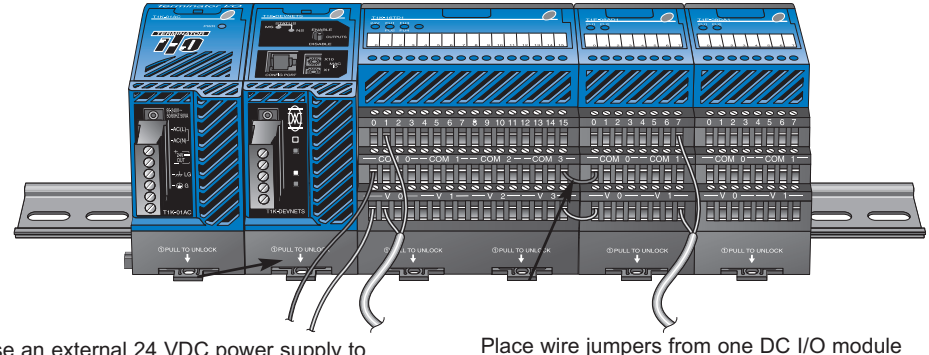
Using T1K-01AC for External 24 VDC Power



Use T1K-01AC external 24 VDC to create a power bus for DC modules.

Place wire jumpers from one DC I/O module base to another as necessary to continue the external 24 VDC power bus.

Using an External 24 VDC Power Supply



Use an external 24 VDC power supply to create a power bus for the DC modules.

Place wire jumpers from one DC I/O module base to another as necessary to continue the external 24 VDC power bus.

I/O Wiring Checklist

Use the following guidelines when wiring the base terminals in your system.

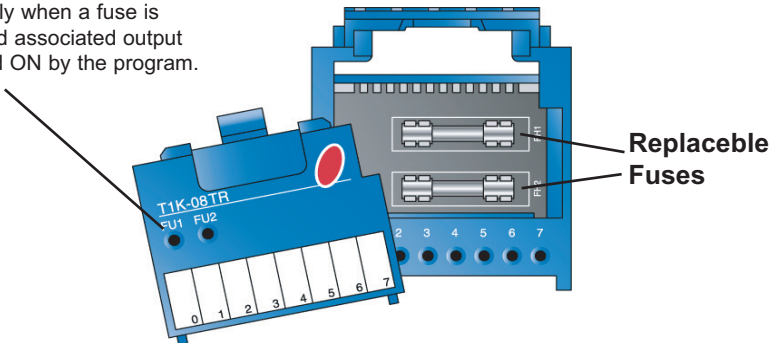
1. There is a limit to the size of wire the terminals can accept. The table below lists the suggested AWG for each module type.
2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible wire length.
4. Use wire trays for routing where possible.
5. Avoid running wires near high-energy wiring.
6. Avoid running input wiring close to output wiring where possible.
7. To minimize voltage drops when wires must run a long distance, consider using multiple wires for the return line.
8. Avoid running DC wiring in close proximity to AC wiring where possible.
9. Avoid creating sharp bends in the wires.
10. To reduce the risk of having a module with a blown fuse, we suggest you add external fuses to your I/O wiring. A fast blow fuse, with a lower current rating than the I/O module fuse can be added to each common, or a fuse with a rating of slightly less than the maximum current per output point can be added to each output.

Output Module Fusing

All Terminator I/O discrete output modules have internal user–replaceable fuses. For fuse specifications and part numbers for a specific output module, refer to the output module specifications later in this chapter. Be sure to remove system power or disable outputs via the Base Contoller switch before attempting to remove the I/O module from its base. Refer to the next section "I/O Module Hot Swap Feature" if attempting to remove an I/O module with the system power ON.

Fuses located under top cover of output modules

Note: A blown fuse indicator illuminates only when a fuse is blown and and associated output point is turned ON by the program.



I/O Module Hot Swap Feature

The “Hot Swap" feature allows Terminator I/O modules to be replaced with Terminator I/O system power ON. Be careful not to touch the terminals with your hands or any conductive material to avoid the risk of personal injury or equipment damaged. Always remove power if it is equally convenient to do so.

WARNING: Only authorized personnel fully familiar with all aspects of the application should replace an I/O module with system power ON.

The Base Controllers in the table to the right support the “Hot Swap” feature.

Base Controller	Supports “Hot Swap”
T1K-DEVENETS	Yes
T1K-MODBUS	Yes
T1K-RSSS	Yes
T1H-EBC(100)	Yes (refer to T1H-EBC-M or T1H-PBC-M User Manual for “Hot Swap” information)
T1H-PBC	

The table to the right shows which modules can or cannot be “Hot Swapped”.

Module	Can be “Hot Swapped”
Power Supply	No
Base Controller	No
I/O Modules (discrete / analog)	Yes

Hot Swap: I/O Module Replacement

The following steps explain how to “Hot Swap" an I/O module.

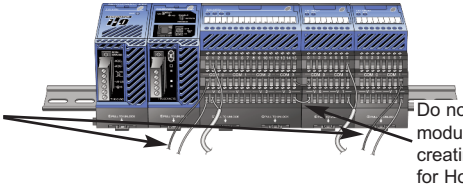
1. Remove I/O module from base.
2. Install new I/O module of the same part number.
3. Verify that the Base Controller LEDs have returned to normal.

Outputs Enable / Disable Switch

A feature that may be used in a non-continuous process application is the Outputs Enable/Disble switch. The switch is located on the front of the T1K-(DEVNETS, MODBUS, RSSS) base controllers. When the switch is in the Disable position all outputs are disabled (OFF), although discrete and analog input data continues to be read. This option may be used at a convenient time during the process application to replace an I/O module.

Check External 24 VDC Wiring Before Hot Swapping

Before ”Hot Swapping" an analog I/O module or a DC output module in a Terminator I/O system, make sure that each of the analog I/O and DC output module's 24 VDC and 0 VDC base terminals are wired directly to the external power supply individually (see diagram below). If the external 24 VDC / 0 VDC is jumpered from base to base in a daisy chain fashion, and an analog I/O or DC output module is removed from its base, the risk of disconnecting the external 24 VDC to the subsequent I/O modules exists.


Wire each analog or DC output module independently to the external power supply.
Do not jumper modules together creating 24 VDC bus for Hot Swap.

Calculating the Power Budget

Managing the Power Resource

When determining the types and quantity of I/O modules to be used in the Terminator I/O system, it is important to remember there is a limited amount of power available from the power supply. A chart is provided to help you easily see the amount of power available with AC and DC power supplies. At the end of this section you will also find an example of power budgeting and a worksheet showing sample calculations.

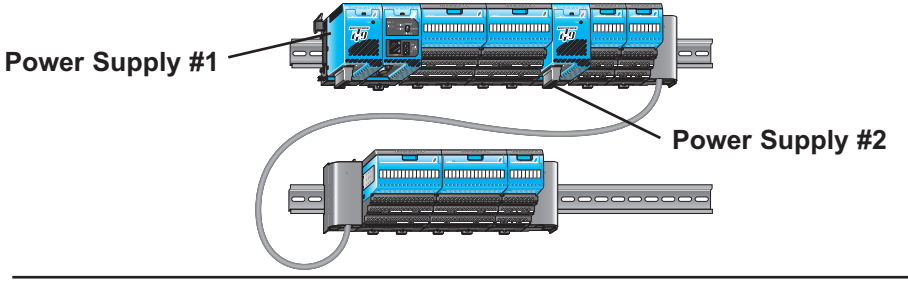
If the chosen I/O exceeds the maximum power available from the power supply the problem is corrected by simply adding another power supply .

WARNING: It is extremely important to calculate the power budget correctly. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

Power Supply Specifications

The following chart shows the amount of current **supplied** by the Terminator I/O power supply. Use this to calculate the power budget for your system. The Auxiliary 24 V Power Source mentioned in the table can be used to power field devices or modules that require an external 24 VDC.

AC Power Supply	5 VDC Current Supplied in mA (internal)	Auxiliary 24 VDC Power Source Current Supplied in mA	DC Power Supply	5 VDC Current Supplied in mA (internal)	Auxiliary 24 VDC Power Source Current Supplied in mA
T1K-01AC	2000	300	T1K-01DC	2000	-
A max. of 500 mA @ 24 VDC can be achieved by lowering the 5 VDC to 1500 mA	1500	500	-	-	-



NOTE: Important about Power Supplies *- One power supply is required in the leftmost component position (Power Supply #1), as shown above. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. Each power supply powers the modules to its right, but is interrupted by the next power supply. It is not mandatory to have a power supply in the leftmost position on an expansion rack.*

The system shown above: *The first Power Supply (PS#1) powers the network interface module and the two I/O modules to its right. The second Power Supply (PS#2) powers the remaining five I/O modules. This is only an example and the power budget requirements vary depending on the I/O modules used.*

Module Power Requirements

This chart shows the amount of maximum current ***required*** for each of the Terminator I/O modules. Use this information to calculate the power budget for your system. If an external 24 VDC power source is required, you can use the built-in 24 VDC auxiliary supply as long as you do not exceed the power budget. If any device is connected to the Controller's serial port that uses the 5 VDC supply pin, be sure to include the device's power consumption in your 5 VDC power budget calculation.

Base Controller and I/O Module Power Consumption					
Module	**5 VDC (mA)**	**24 VDC (mA)**	**Module**	**5 VDC (mA)**	**24 VDC (mA)**
Base Contollers			**AC Output Module**		
T1K-RSSS	250	0	T1K-08TA	250	0
T1K-DEVNETS	190	(see note 1)	T1K-16TA	450	0
T1H-EBC(100)	350	0	T1K-08TAS	300	0
T1K-MODBUS	250	0	**Relay Output Modules**		
T1H-PBC	530	0	T1K-08TR	350	0
DC Input Modules			T1K-16TR	700	0
T1K-08ND3	35	0	T1K-08TRS	400	0
T1K-16ND3	70	0	**Analog Input Modules**		
AC Input Modules			T1F-08AD-1	75	50 (see note 2)
T1K-08NA-1	35	0	T1F-16AD-1	75	50 (see note 2)
T1K-16NA-1	70	0	T1F-08AD-2	75	50 (see note 2)
DC Output Modules			T1F-16AD-2	75	50 (see note 2)
T1K-08TD1	100	200 (see note 2)	T1F-16RTD	150	0
T1K-08TD2-1	100	0	T1F-14THM	60	70 (see note 2)
T1H-08TDS	200	0	**Analog Output Modules**		
T1K-16TD1	200	400 (see note 2)	T1F-08DA-1	75	150 (see note 2)
T1K-16TD2-1	200	0	T1F-16DA-1	75	150 (see note 2)
Combination Analog Modules			T1F-08DA-2	75	150 (see note 2)
T1F-8AD4DA-1	75	60 (see note 2 and 3)	T1F-16DA-2	75	150 (see note 2)
T1F-8AD4DA-2	75	70 (see note 2)	**Specialty Modules and other devices (see note 4)**		
			T1H- CTRIO	400	0

Note 1: The T1K-DEVNETS consumes 45mA @ 11-25 VDC from the DeviceNet System.

Note 2: Use T1K-01AC 24 VDC auxiliary supply or external user supply.

Note 3: 60 mA plus 20 mA per output loop

Note 4: If any device is connected to the Controller's serial port that uses the 5 VDC supply pin, be sure to include the device's power consumption in your 5 VDC power budget calculation

NOTE: Important Power Budget - *For each power supply in a system, make sure the current required by the interface and I/O modules does not exceed the current supplied at both 5 VDC and 24 VDC.*

Power Budget Calculation Example

The following example shows how to calculate the power budget for the first slave unit of an I/O system.

SLAVE (Node) #1			
Power Supply #1	**Part Number**	**5 VDC (mA) Required**	**24 VDC (mA) Required**
Power Supplied T1K-01AC (see pg. 3-18)		**2000**	**300**
Slave	T1H-EBC100	350	0
Module	T1K-16NA-1	70	0
Module	T1K-16TA	450	0
Other (OI, etc.)	-	0	0
Maximum power required		**870**	**0**
Remaning power available		**2000-870 = 1130**	**300-0 = 300**
Power Supply #2	**Part Number**	**5 VDC (mA) Required**	**24 VDC (mA) Required**
Power Supplied T1K-01AC (see pg. 3-18)		**1500**	**500**
Module	T1K-08AD-2	75	50
Module	T1K-08AD-2	75	50
Module	T1K-16TD1	200	400
Module	T1K-08TR	350	0
Module	T1K-08ND3	35	0
Other	-	0	0
Maximum power required		**735**	**500**
Remaining power available		**1500-735 = 765**	**500-500 = 0 (see note 1)**

Note 1: An external user power supply must be used in if the 24 VDC current requirement exceeds the T1K-01AC 24 VDC auxiliary supply.

1. When using the tables at the beginning of the Power Budgeting section of this chapter, fill in the information for the base controller, I/O modules, and any other devices that will use system power, including devices that use the 24 VDC output. Devices which fall into the “Other" category are devices such as an operator interface which also has power requirements but do attach as a module to the system.

2. Add the current columns starting with the slave and put the total in the row labeled ”Maximum power required".

3. Subtract the row labeled “Maximum power required" from the “Power Supplied". Place the difference in the row labeled “Remaining Power Available".

4. If “Maximum Power Required" is greater than “Power Supplied" in either of the two columns, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your I/O configuration.

Power Budget Worksheet

This blank chart is provided for you to copy and use to calculate the power budget.

SLAVE # _____			
Power Supply # _____ _____	Module Part Number	5 VDC (mA) (required)	Auxiliary Power Source 24 VDC Output (mA) (required)
Power Supplied			
Other			
Maximum power required			
Remaining power available			

I/O Specification Terms

Inputs or Outputs Per Module
Indicates number of input or output points per module and designates current sinking, current sourcing, or either.

Commons Per Module
Number of commons per module and their electrical characteristics.

Input Voltage Range
The operating voltage range of the input circuit.

Output Voltage Range
The operating voltage range of the output circuit.

Peak Voltage
Maximum voltage allowed for the input circuit.

AC Frequency
AC modules are designed to operate within a specific frequency range.

ON Voltage Level
The voltage level at which the input point will turn ON.

OFF Voltage Level
The voltage level at which the input point will turn OFF.

Input impedance
Input impedance can be used to calculate input current for a particular operating voltage.

Input Current
Typical operating current for an active (ON) input.

Minimum ON Current
The minimum current for the input circuit to operate reliably in the ON state.

Maximum OFF Current
The maximum current for the input circuit to operate reliably in the OFF state.

Minimum Load
The minimum load current for the output circuit to operate properly.

External DC Required
Some output modules require external power for the output circuitry.

ON Voltage Drop
Sometimes called “saturation voltage”, it is the voltage measured from an output point to its common terminal when the output is ON at max. load.

Maximum Leakage Current

The maximum current a connected maximum load will receive when the output point is OFF.

Maximum Inrush Current

The maximum current used by a load for a short duration upon an OFF to ON transition of a output point. It is greater than the normal ON state current and is characteristic of inductive loads in AC circuits.

Base Power Required

Power from the base power supply is used by the Terminator I/O modules and varies between different modules. The guidelines for using module power is explained in the power budget section of this manual.

OFF to ON Response

The time the module requires to process an OFF to ON state transition.

ON to OFF Response

The time the module requires to process an ON to OFF state transition.

Terminal Type

Indicates whether the terminal type is a removable or non-removable connector or a terminal.

Status Indicators

The LEDs that indicate the ON/OFF status of an input point. These LEDs are electrically located on either the logic side or the field device side of the input circuit.

Weight

Indicates the weight of the module.

Fuses

Protective devices for an output circuit, which stop current flow when current exceeds the fuse rating. They may be replaceable or non–replaceable, or located externally or internally.

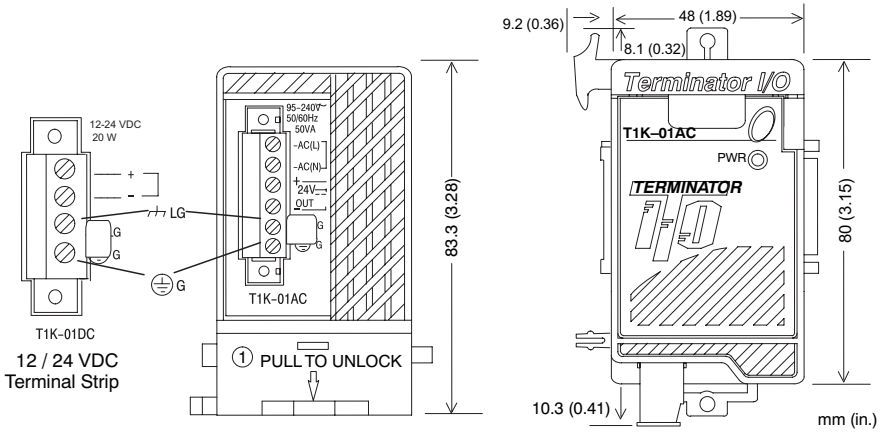
T1K-01AC, T1K-01DC Power Supply

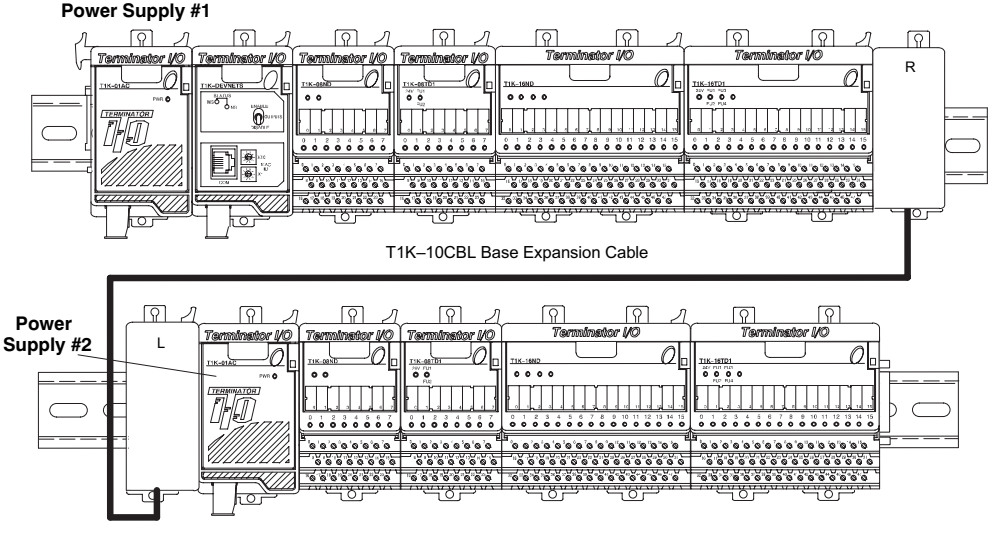
Specifications			
Specification		**T1K-01AC**	**T1K-01DC**
Input Voltage Range		110 / 220 VAC (85 - 264 VAC)	12 / 24 VDC (10.8 - 26.4 VDC)
Input Frequency		50 / 60 Hz (47-63 Hz)	-
Maximum Power		50 VA	20 W
Maximum Inrush Current		20 A	10 A
Insulation Resistance		> 10 MΩ @ 500 VDC	
Voltage Withstand (Dielectric)		1 min. @ 1500 VAC between primary, secondary and field ground	
Auxiliary 24 VDC Supply		300 mA maximum	-
Output 1: 5 VDC Base Power Supplied	Voltage	5.25 VDC (5.00 - 5.50 VDC)	5.25 VDC (5.00 - 5.50 VDC)
	Current	a) 2.0 A maximum b) 1.5 A maximum (see note)	2.0 A maximum
	Ripple	5% maximum	5% maximum
Output 2: 24 VDC Base Power Supplied	Voltage	24 VDC (20.0-28.0 VDC)	-
	Current	a) 300 mA maximum b) 500 mA maximum (see note)	-
	Ripple	10% maximum	-
Replacement Terminal Block - Phoenix Contact		MVSTBW 2.5/4-ST-5.08 BK	MVSTBW 2.5/6-ST-5.08 BK
Fuse		1 (Primary) not replaceable	

NOTE: *500 mA @ 24 VDC is achieved by lowering the 5 VDC to 1.5 A from 2.0 A.*

Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)

Dimensions





Note 1: The T1K–DEVNETS consumes 45 mA @ 11–25 VDC from the DeviceNet System
Note 2: Use T1K–01AC 24 VDC auxiliary supply or external user supply

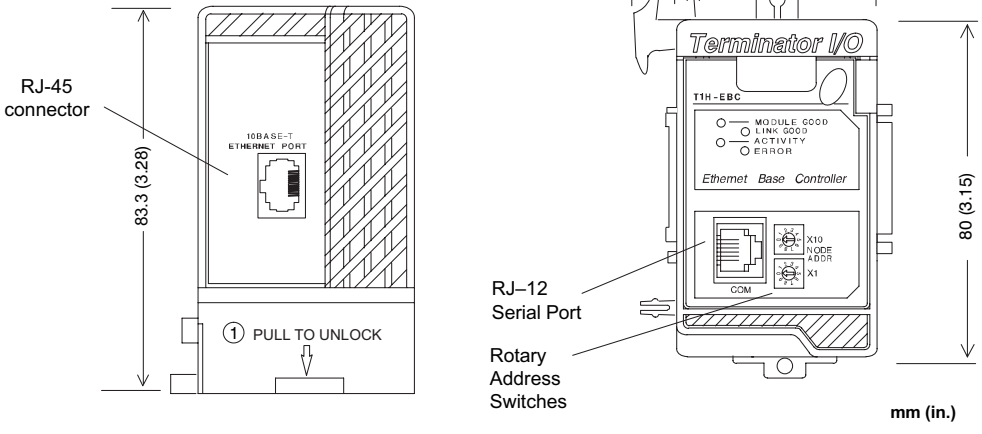
Important Power Budget Note: For each power supply in a system, make sure the current required by the interface and I/O modules does not exceed the current supplied at both 5 VDC and 24 VDC.

T1H-EBC Ethernet Base Controller (Obsolete)

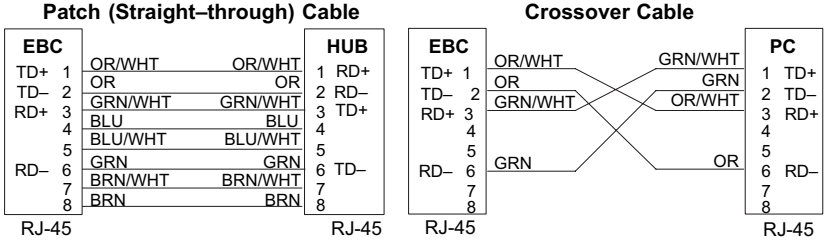
Specifications	
Module Type	Ethernet Slave
Communications	10Base-T
Auto-configuring	I/O type/position automatically identified during power-up
Ethernet Protocols	UDP/IP, IDX
Ethernet Port	RJ-45
Node Address	1 to 99 (decimal) set by rotary switches or software (0 used for setting address via software only)
Link Distance	100 meters (328 feet)
Data Transfer Rate	10 Mbps
LED Indicators **NOTE:** All indicators re-initialize during power-up. For more information consult the T1H-EBC-M User Manual.	MODULE GOOD (green) On = module passed diagnostics check during last power-up Fast Blink = configured I/O module no longer reporting (see auto-configuring above) Slow Blink = unconfigured I/O module added to system (see auto-configuring above) LINK GOOD (green) On = 10Base-T link pulses are being received ACTIVITY (red) On = Ethernet network activity detected ERROR (red) On = watchdog timer timeout represents hardware, communications or network fault; power-on reset or reset within master device software
Communications Port	RJ-12, RS-232C K-Sequence protocol, ASCII (not functional when used with H2-ERM).
Base Power Requirements	350 mA @ 5 VDC (EBC); Serial port supports up to 500 mA @ 5 VDC (add for power budget consumption).

General Specifications	
Installation Requirements	Mounts to the right of the first power supply.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)

Dimensions

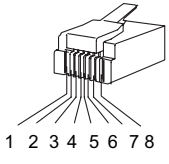


T1K-EBC Ethernet Port Pinout



This diagram illustrates the standard wire positions in the RJ-45 connector.
We strongly reccommend that you use Category 5 or better, UTP cable.

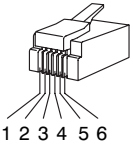
10BaseT



8-pin RJ-45 connector
(8P8C)

T1K-EBC Serial Port Pinout

RJ-12



6-pin RJ-12 connector

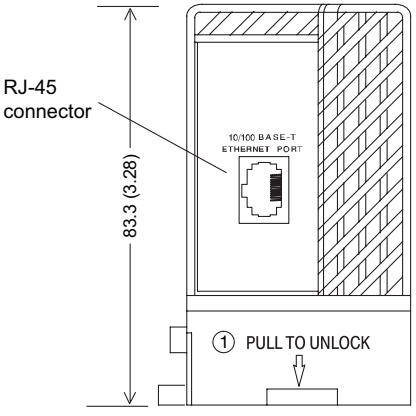
Serial Port Pin Descriptions		
Pin	**Signal**	**Definition**
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	5 V	Request to send
6	0 V	Clear to Send

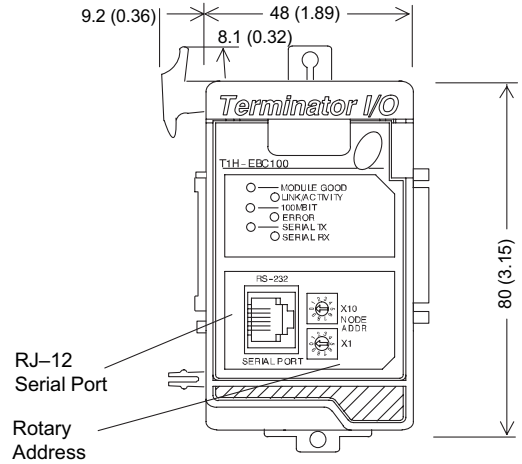
T1H-EBC100 Ethernet Base Controller

Specifications	
Module Type	Ethernet Slave
Communications	100Base-T Ethernet
Auto-configuring	I/O type/position automatically identified during power-up
IP Configuration	_Obtain an IP address from a DHCP Server automatically at power-up (Default); _Dedicated IP address using NetEdit3 or HTML configuration.
Ethernet Protocols	UDP/IP, IPX, MODBUS TCP
Ethernet Port	RJ-45
Node Address	1 to 99 (decimal) set by rotary switches or software; 0 (default, used for setting address via software only)
Link Distance	100 meters (328 feet)
Data Transfer Rate	100 MBaud or 10 MBaud (auto-detect)
LED Indicators **NOTE:** All indicators re-initialize during power-up. For more information consult the T1H-EBC-M User Manual.	MODULE GOOD (green): On = module passed diagnostics check during last power-up Fast Blink = configured I/O module no longer reporting (see auto-configuring above) Slow Blink = unconfigured I/O module added to system (see auto-configuring above) LINK / ACTIVITY (green): On = Ethernet network activity detected 100 MBit (green): On = Ethernet network activity detected at 100 Mbps Off = (with LINK / ACTIVITY On) Ethernet activity is auto-detected at 10 Mbps ERROR (red) On = watchdog timer timeout represents hardware, communications or network fault; power-on reset or reset within master device software SERIAL TX (green): On = EBC RJ12 serial port is transmitting SERIAL RX (green): On = EBC RJ12 serial port is receiving
Serial Communications Port	RJ-12, RS-232C K-Sequence protocol, ASCII, MODBUS RTU [not functional when used with H2-ERM(100), H4-ERM(100), or H2-DM1(E)].
Base Power Requirement	350 mA @ 5 VDC (EBC); Serial port supports up to 500 mA @ 5 VDC (add for power budget consumption).

General Specifications	
Installation Requirements	Mounts to the right of the first power supply.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)

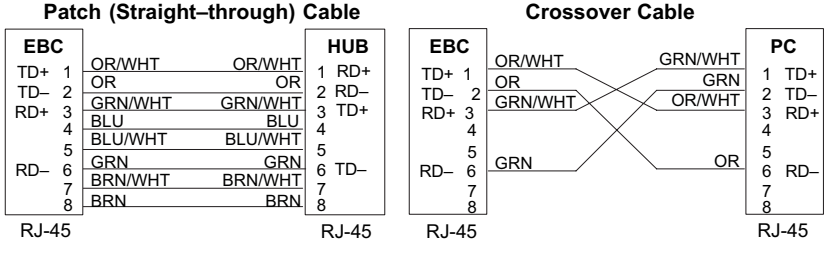
Dimensions





mm (in.)

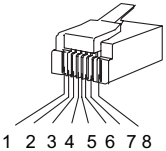
T1K-EBC100 Ethernet Port Pinout



This diagram illustrates the standard wire positions in the RJ-45 connector.
We strongly reccommend that you use Category 5 or better, UTP cable.

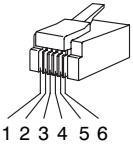
T1K-EBC100 Serial Port Pinout

10 / 100BaseT



8-pin RJ-45 connector
(8P8C)

RJ-12



6-pin RJ-12 connector

Serial Port Pin Descriptions		
Pin	**Signal**	**Definition**
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	5 V	Request to send
6	0 V	Clear to Send

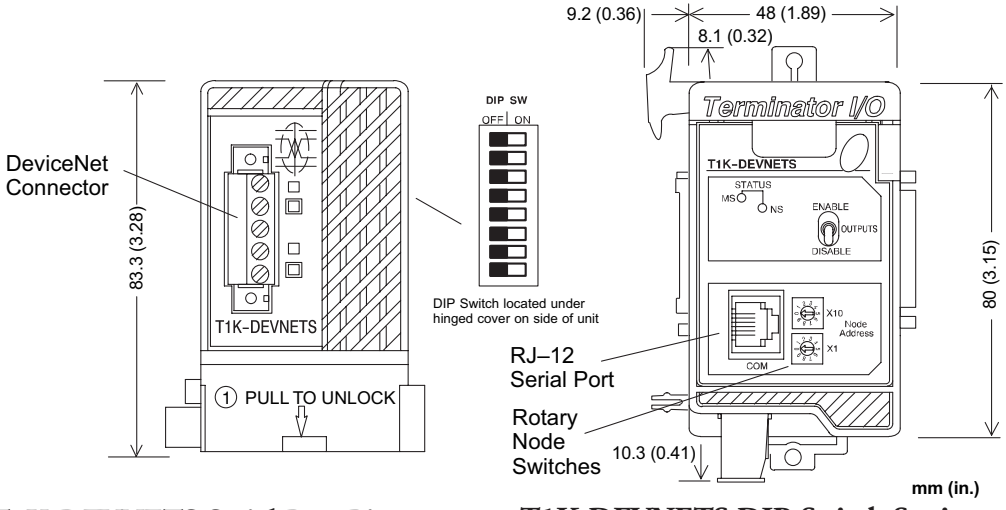
T1K-DEVNETS

Communications Specification	
Communication Form	DeviceNet Communication Protocol (Slave) Predefined Master/Slave Group 2 Server only
Network Node Address	0 to 63 (Rotary switch setting)
Data Packet	0 to 8 Bytes (Data beyond eight bytes are divided.)
Communication Rate (Maximum cable length)	125000 Baud (1640 ft. / 500 m) 250000 Baud (820 ft. / 250 m) 500000 Baud (328 ft. / 100 m)
Communication Status Indicators	MS: Module Status LED Green: normal device operation Red: unrecoverable controller fault NS: Network Status LED Green: communication link online and connected Green flashing: on-line, but not connected Red: critical link or controller failure Red flashing: connection time-out
DeviceNet Power Consumption	45 mA @ 11 to 25 VDC
Base Power Consumption	190 mA @ 5 VDC

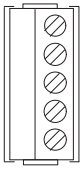
DeviceNet Specifications			
Device Type	Generic	Configuration Consistency	No
Explicit Peer to Peer Message	No	Fault Node Recovery	No
I/O Peer to Peer Message	No	Master Scanner	No
Communication Baud Rate 125 K, 250 K, 500 K	Yes	I/O Slave Message Bit Strobe Polling Cyclic Change of State	 No Yes No No

General Specifications	
Installation Requirements	Must mount to the right of the first power supply in a slave system.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% relative humiditiy (Non-condensing)
Voltage Withstand	1500 VAC, 1 minute (DeviceNet connector internal)
Insulation Resistance	500 VDC, 10 MΩ (DeviceNet connector internal)
Vibration Resistance	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA (ICS3-304) Impulse Noise 1 μs, 1000 V FCC class A RFI (145 MHz, 435 MHz 10 W, 10 cm)
Atmosphere	No corrosive gases Environmental Pollution Level 2
Weight	6.0 oz (170 g)

Dimensions

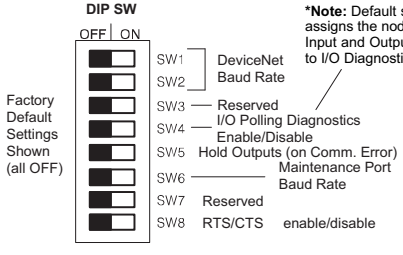


T1K-DEVNETS Serial Port Pinout

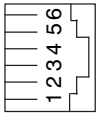


Use Belden Cable 3084A, or equivalent.

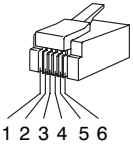
T1K-DEVNETS DIP Switch Settings



Serial Port



RJ-12



Serial Port Pin Descriptions		
Pin	**Signal**	**Definition**
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	RTS	Request to send
6	CTS	Clear to Send

SW 1-2 DeviceNet Baud Rate		
Baud Rate	**SW1**	**SW2**
125k bps	OFF	OFF
250k bps	ON	OFF
500k bps	OFF	ON
Reserved	ON	ON

SW 4 Disable I/O Polling Diagnostics	
I/O Diagnostics	**SW4**
Enable	OFF
Disable	ON

*See Dip SW 4 Note above.

SW 5 Hold Outputs	
Outputs	**SW5**
Turn Off	OFF
Hold	ON

SW 6 Maintenance Port Baud Rate	
Baud Rate	**SW6**
9600 bps	OFF
19200 bps	ON

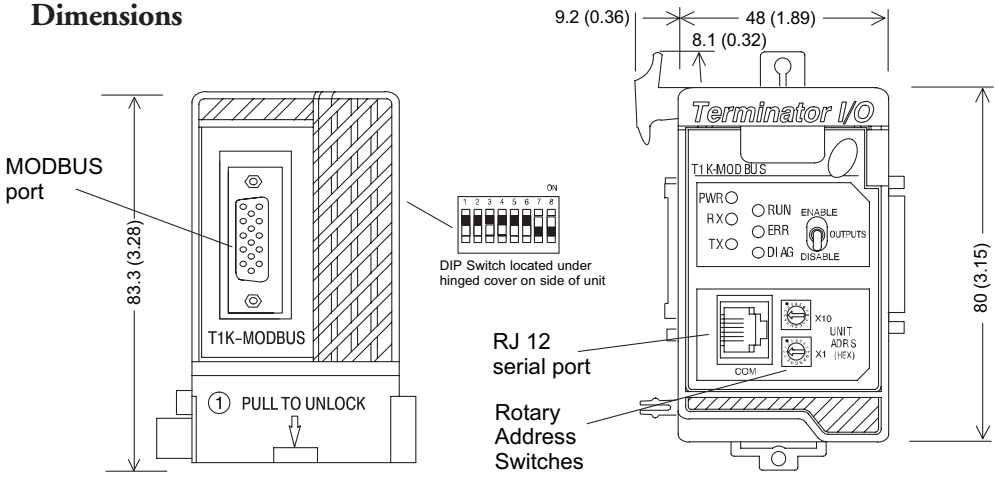
SW 8 RTS / CTS Enable / Disable	
RTS/CTS	**SW8**
Disable	OFF
Enable	ON

T1K-MODBUS Base Controller

Specifications	
Communication Protocol	MODBUS RTU (Slave)
MODBUS Connector	15-pin female D-shell
MODBUS Port Type	RS-232C, RS-422 / 485
Station Address	1 to F7h (247), Rotary switch setting
Number of I/O Points	Discrete: Inputs: 1024, Outputs: 1024 Analog: Inputs: 64 Channels, Outputs: 64 Channels
Communication Baud Rate	(300, 600, 1200, 4800, 9600, 19200, 38400) Baud Dip Switch 1-3 Set
Communication Data	8-bit (fixed), 1 Start bit, 1 0r 2 Stop bit Parity: None / Odd / Even; configure using Setup Tool Defaults: 8 (fixed), 1, 1, Odd
Communication Time out	500 ms, 1 sec, 2.5 sec, 5 sec, 10 sec, 25 sec, 60 sec Default: 1 sec.; configure using Setup Tool
RTS On / Off Delay Time	(0, 2, 5, 10, 50, 100, 500) ms Default: 0 ms; cofigure using Setup Tool
Status Indicators	RWR (green): ON when power good RX (green): ON when data is being received TX (green): ON when data is being transmitted RUN (green): ON when communicating with Master ERR (red): Communication error DIAG (red): I/O system error
Output Enable Switch	Enable: outputs are enabled Disable: outputs are disabled
Installation Requirement	Must mount to the right of the first power supply in a slave system.
Base Power Requirements	250 mA @ 5 VDC
Communication Port (RJ-12 Serial Port)	RJ-12, RS-232C Use to configure MODBUS port usning MODBUS Setup Tool Utility or use to upgrade firmware Baud rate: 9600, 19.2000 Baud (set with Dip Switch 6) Fixed settings: 8 data bits, 1 start bit, parity Odd

General Specifications	
Installation Requirements	Must mount to the right of the first power supply in a slave system.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	30% to 95% relative humiditiy (Non-condensing)
Voltage Withstand	1500 VAC, 1 minute (15-pin connector internal)
Insulation Resistance	500 VDC, 10 MΩ
Vibration Resistance	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA (ICS3-304) Impulse Noise 1 μs, 1000 V FCC class A RFII (145 MHz, 435 MHz)
Atmosphere	No corrosive gases Environmental Pollution Level 2
Weight	6.0 oz (170 g)

Dimensions



mm (in.)

T1K-MODBUS DIP Switch Settings

MODBUS Port Pin-out		
Pin		**Signal Definition**
1	5 V	5 VDC
2	TXD	Transmit Data (RS-232C)
3	RXD	Receive Data (RS-232C)
4	RTS	Request to Send (RS-232C)
5	CTS	Clear to Send (RS-232C)
6	RXD-	Receive Data - (RS-422)
7	0 V	Logic Ground
8	0 V	Logic Ground
9	TXD+	Transmit Data + (RS-422)
10	TXD-	Transmit Data - (RS-422)
11	RTS+	Request to Send + (RS-422)
12	RTS-	Request to Send - (RS-422)
13	RXD+	Receive Data + (RS-422)
14	CTS+	Clear to Send + (RS-422)
15	CTS-	Clear to Send - (RS-422)

SW 1-3 MODBUS Port Baud Rates			
Baud Rate	**SW 1**	**SW 2**	**SW 3**
300	OFF	OFF	OFF
600	ON	OFF	OFF
1200	OFF	ON	OFF
2400	ON	ON	OFF
4800	OFF	OFF	ON
9600	ON	OFF	ON
19200	OFF	ON	ON
38400	ON	ON	ON

SW 6 Maintenance Port Baud Rate	
Baud Rate	**SW6**
9600	OFF
19200	ON

SW 7 MODBUS RTU Addressing Mode	
Mode	**SW7**
584/984	OFF
DirectLogic	ON

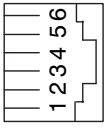
SW 4 Communication Setting Mode	
Default Mode	OFF
Option Mode (see T1K-MODBUS Manual)	ON

SW 8 RTS / CTS Enable / Disable	
RTS / CTS	**SW8**
Disable	OFF
Enable	ON

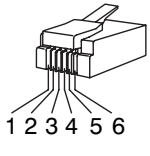
SW 5 Hold Output	
Outputs	**SW5**
Turn Off	OFF
Hold	ON

Serial Port Pin-out	
Pin	**Signal**
1	0 V
2	+ 5 V
3	RXD
4	TXD
5	RTS
6	CTS

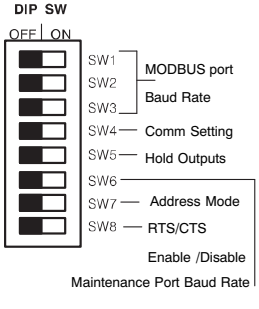
RJ-12 port



RJ-12 plug on cable



Default Mode	
Communication Data	8 Bit
Start Bit	1 Bit
Stop Bit	1 Bit
Parity Bit	Odd
Communication Time Out	1 sec.
RTS ON Delay Time	0 ms
RTS OFF Delay Time	0 ms

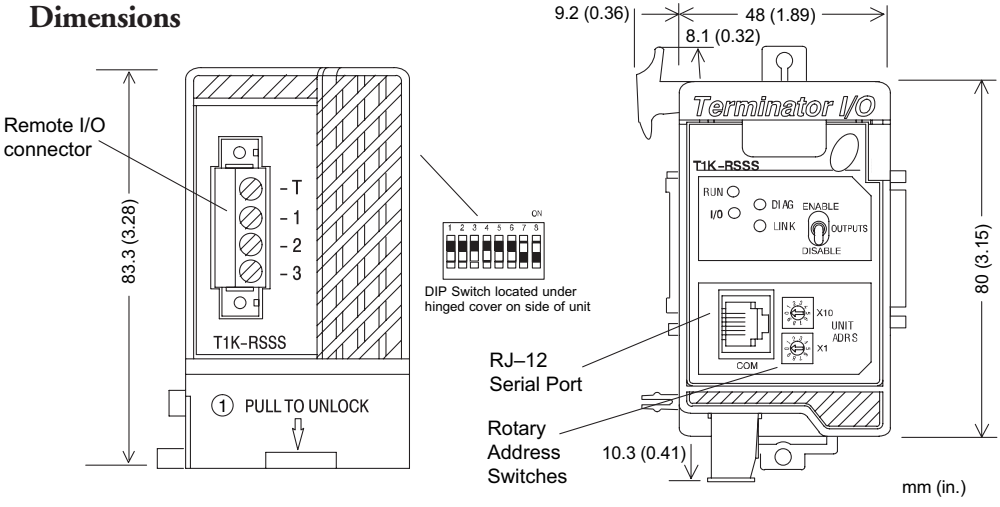


T1K-RSSS Remote I/O Base Controller

Specification				
Module Type	non-intelligent slave			
Protocol	SM-NET		RM-NET	
Station Address	1 to 31 set by rotary switches		1 to 7 set by rotary switches	
Number of Masters per PLC CPU	Check PLC CPU / remote Master module remote I/O specifications			
Max. Slave I/O Points per PLC CPU				
Baud Rate / Communication Distance (set by DIP switches)	**Baud Rate**	**Distance**	**Baud Rate**	**Distance**
	19200 38400 153600 307200 614400	1200 m 1200 m 600 m 300 m 100 m	19200 38400	1.2 Km 1.2 Km
LED Indicators	RUN: On when communication is active. DIAG: On when a slave hardware failure error occurs. I/O Fast Blink: I/O error (250 ms on / off time). Slow Blink: I/O configuration error while outputs are enabled (500 ms on / off time). Continuous ON: I/O and configuration error. LINK: On when a communication error occurs.			
Output Enable Switch	Enable: outputs are enabled Disable: outputs are disabled			
Communication Port (active in SM-NET only)	RJ-12, RS-232C (K-Sequence) Dip switch selectable: Baud rate: 4800 - 38400 bps * select 9600 baud for operator interface (default) (other baud rates are for updating T1K-RSSS) Parity: odd (default), even Fixed settings: 8 data bits, 1 start bit, 1 stop bit			
Base Power Requirement	250 mA @ 5 VDC			
Communication Cabling	For remote I/O, RS-485 twisted pair Belden 9841 or equivalent.			

General Specifications	
Installation Requirements	Must mount to the right of the first power supply in a slave.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)

Dimensions



T1K-RSSS DIP Switch Settings

SW 1 Mode	
OFF	SM-NET
ON	RM-NET

SW 2, 3, 4 Baud Rates			
Baud Rate	**SW 1**	**SW 2**	**SW 3**
19200	OFF	OFF	OFF
38400	ON	OFF	OFF
153600	OFF	ON	OFF
307200	ON	ON	OFF
614400	OFF	OFF	ON
Baud rates above 38.4 kbps are for SM-NET only.			

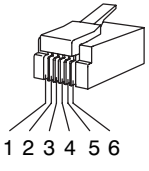
SW 5 Output Default	
Outputs	**SW5**
Clear	OFF
Hold	ON

SW 6 Serial Port Parity	
Odd	OFF
None	ON
SM-NET only	

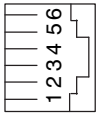
SW 7-8 Serial Port Baud Rate		
Baud Rate	**SW7**	**SW8**
4800	ON	OFF
9600	OFF	OFF
19200	OFF	ON
38400	ON	ON
Port Active in SM-NET only Use 9600, odd parity for Operator Interface		

T1K-RSSS Serial Port Pin-out

RJ-12 plug on cable



RJ-12 socket on T1K-RSSS



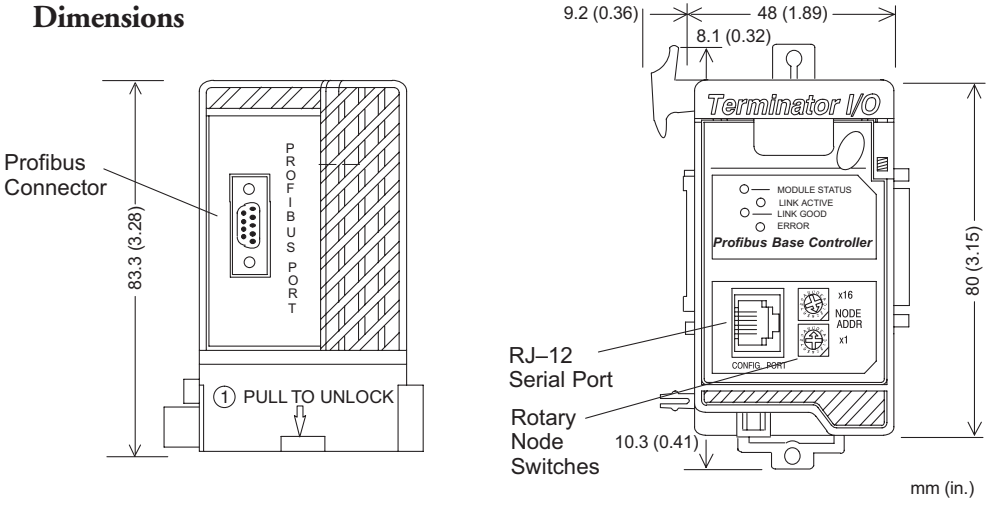
Serial Port Pin Descriptions		
Pin	**Signal**	**Definition**
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	5 V	Request to send
6	0 V	Clear to Send

T1H-PBC Profibus Base Controller

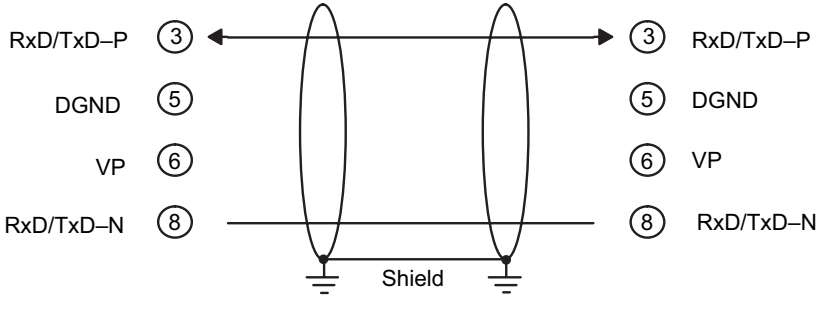
Specifications	
Module Type	Profibus Network Interface Module
Maximum Expansion	32 stations per segment, repeaters max./segment, 126 stations maximum
Communications	RS-485
Auto-configuring	GSD file in Master
Profibus Profile	DP (Decentralized Periphery)
Profibus Port	9-pin D-shell
Node Address	1 to 126 (decimal) set by rotary switches or software (0 used by Master)
Segment Distance	100 meters (328 feet) to 1200 meters (3270 feet)
Baud Rate	Selectable from 9.6 kbps to 12 Mbps
LED Indicators	STATUS (Module): ON = module power-up check passed ACTIVE (Link): ON = Network is active OFF = Network is not active TOKEN (Holding): ON = OFF = Incorrect I/O configuration ERROR: ON = watchdog timer timeout represents hardware, communications or network fault; power-on reset or reset within master device software
Communications Port	RJ-12, RS-232C K-Sequence protocol, ASCII (not functional when used with H2-ERM).
Base Power Requirements	350 mA @ 5 VDC (EBC); Serial port supports up to 500 mA @ 5 VDC (add for power budget consumption).

General Specifications	
Installation Requirements	Must mount to the right of the first power supply.
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA (ICS3-304) Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Manufacturer	Host Automation Products

Dimensions

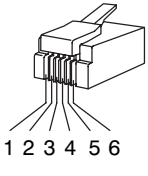


T1H-PBC Port Pinout

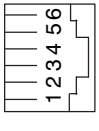


Use Belden Profibus 3079A Cable or Siemens 6XV1 830 0AH10

Serial (Config) Port
(Use for firmware upgrades only)



RJ-12 plug
on cable

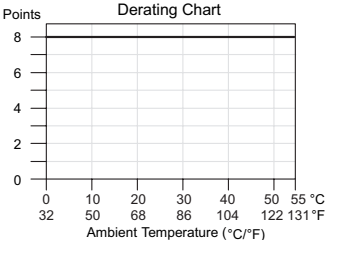


Serial Port Pin Descriptions		
Pin	**Signal**	**Definition**
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	RTS	Request to send
6	CTS	Clear to Send

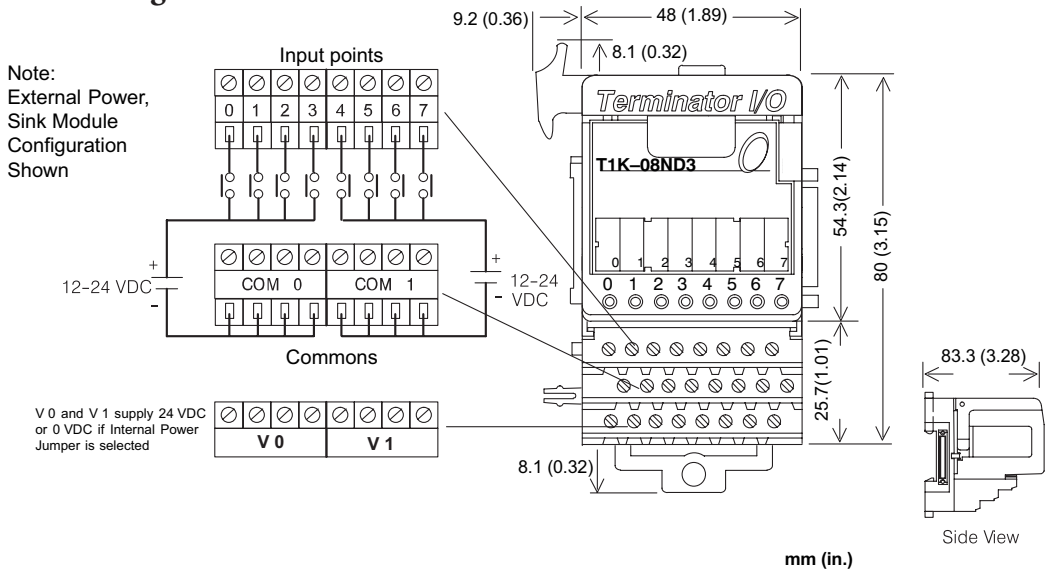
T1K-08ND3 DC Input

Specifications	
Inputs Per Module	8 (sink / source)
Commons Per Module	ext. power: 2, isolated (4 pts. / com.) int. power: 2, all 8 pts. internally connected
Operating Voltage	12 - 24 VDC
Input Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	30 VDC
Input Current (Typical)	4 mA @ 12 VDC, 8.5 mA @ 24 VDC
Input Impedance	2.8 KΩ
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4 mA
Max. OFF Current	0.5 mA
OFF to ON Response	2 - 8 m., Typical: 4 ms
ON to OFF Response	2 - 8 ms, Typical: 4 ms
Base Power Requirements	35 mA @ 5 VDC
Status Indicators	Logic Side
Weight	70 g

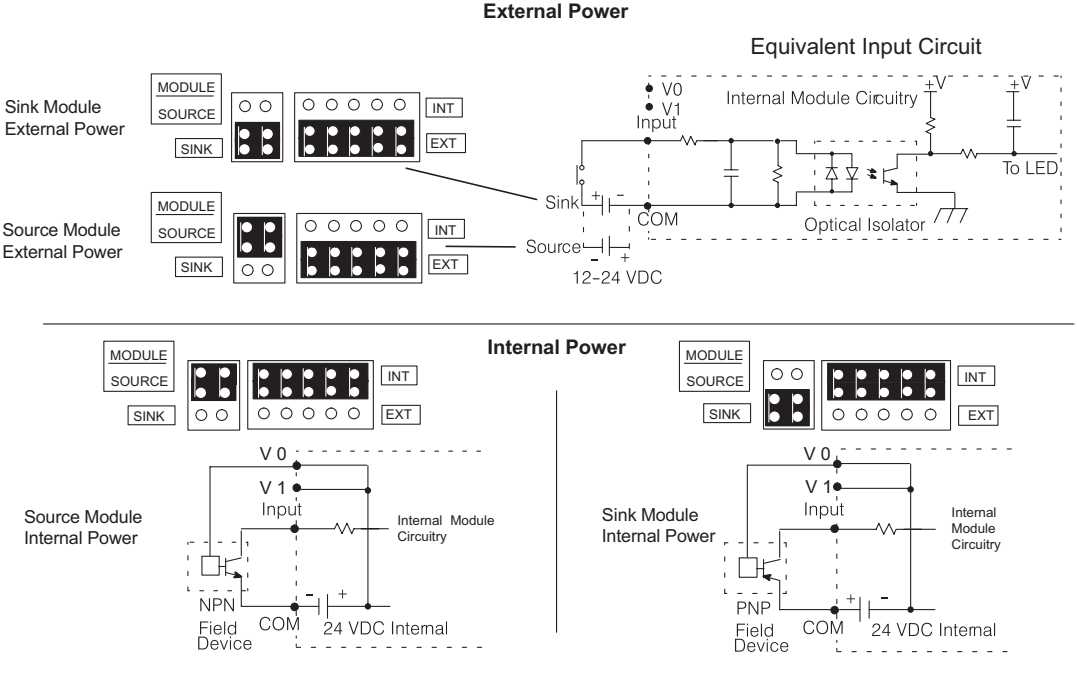
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A



Wiring & Dimensions



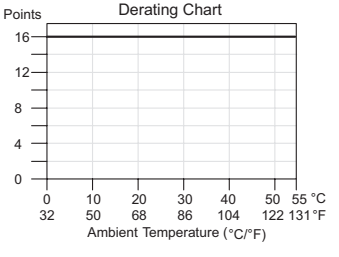
Jumper Selection



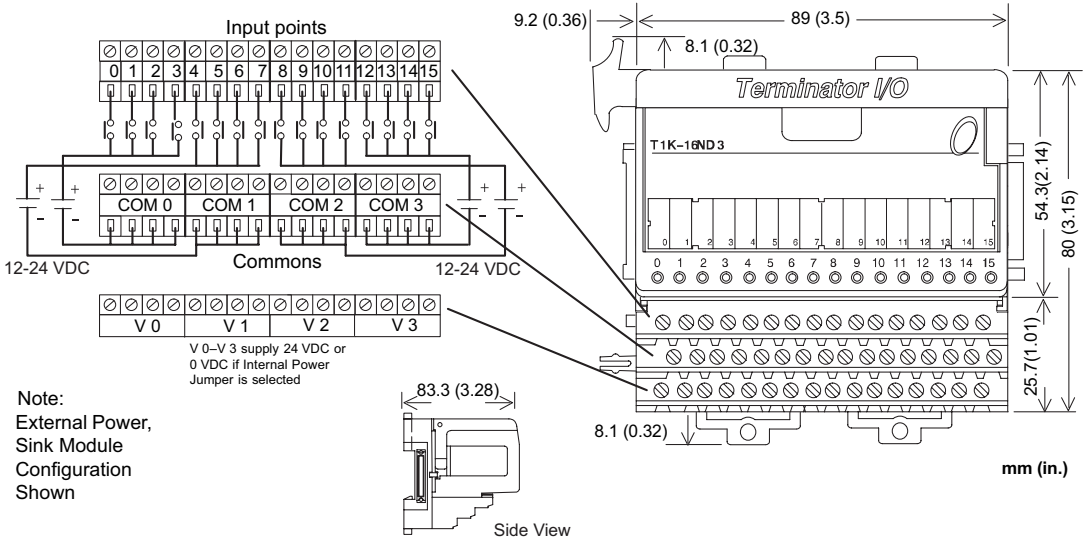
T1K-16ND3 DC Input

Specifications	
Inputs Per Module	16 (sink / source)
Commons Per Module	ext. power: 4, isolated (4 pts. / com.) int. power: 4, all 16 pts. internally connected
Operating Voltage	12 - 24 VDC
Input Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	30 VDC
Input Current (Typical)	4 mA @ 12 VDC, 8.5 mA @ 24 VDC
Input Impedance	2.8 KΩ
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4 mA
Max. OFF Current	0.5 mA
OFF to ON Response	2 - 8 ms, Typical: 4 ms
ON to OFF Response	2 - 8 ms, Typical: 4 ms
Base Power Requirements	70 mA @ 5 VDC
Status Indicators	Logic Side
Weight	160 g

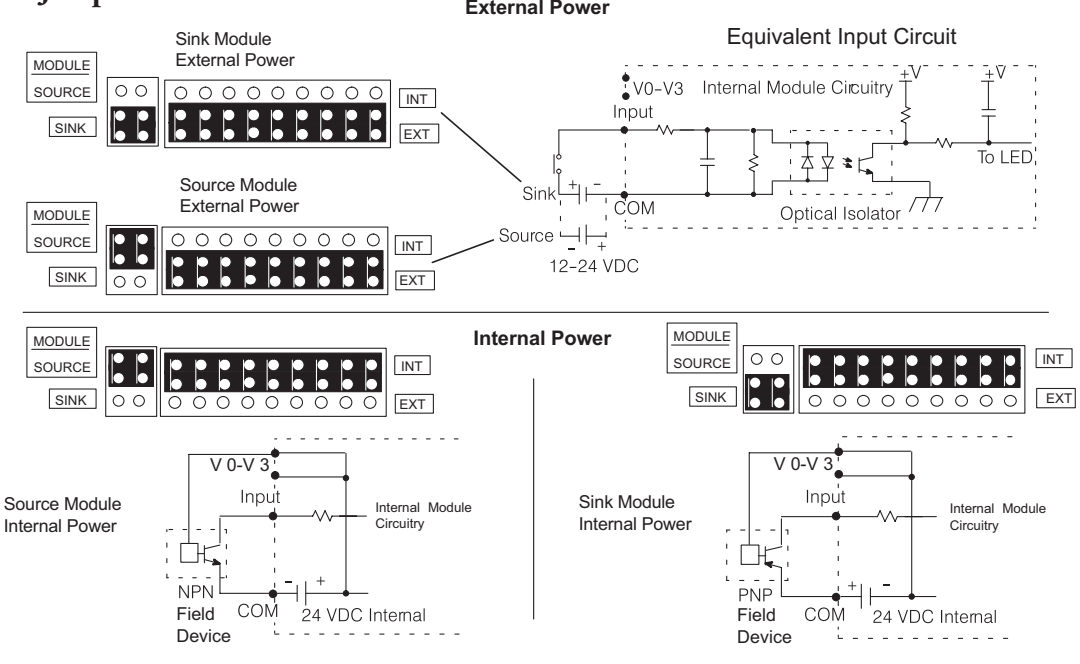
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A



Wiring & Dimensions



Jumper Selection

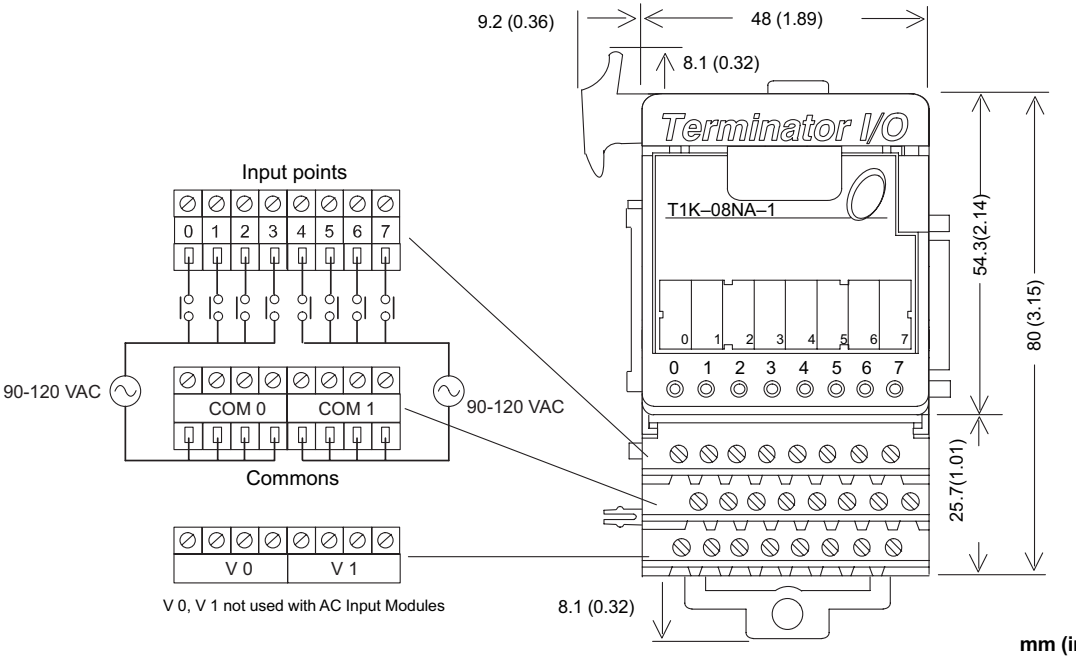


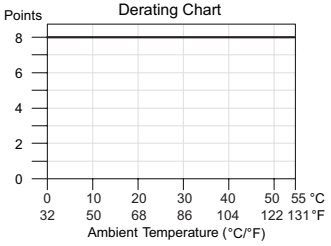
T1K-08NA-1 AC Input

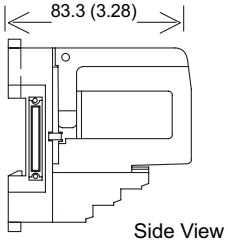
Specifications	
Inputs Per Module	8
Commons Per Module	2, 4 pts. / com. (isolated)
Operating Voltage	90 - 120 VAC, 47 - 63 Hz
Input Voltage Range	80 - 132 VAC, 47 - 63 Hz min. / max.
Input Current	8 mA @ 100 VAC (50 Hz) 10 mA @ 100 VAC (60 Hz) 12 mA @ 132 VAC (50 Hx) 15 mA @ 132 VAC (60 Hz)
Input Impedance	14 KΩ @ 50 Hz, 12 KΩ @ 60 Hz
ON Current / Voltage	> 6 mA @ 75 VAC
OFF Current / Voltage	< 2.0 mA @ 20 VAC
OFF to ON Response	< 40 ms
ON to OFF Response	< 40 ms
Base Power Requirements	35 mA @ 5 VDC
Status Indicators	Logic Side
Weight	70 g

Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

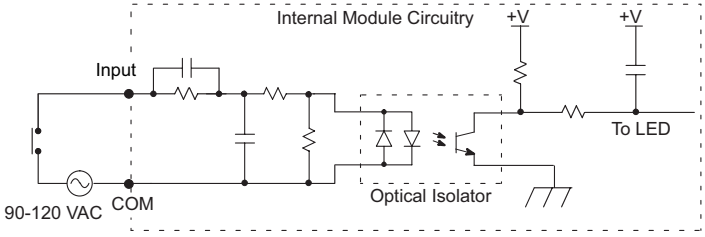
Wiring & Dimensions







Equivalent Input Circuit

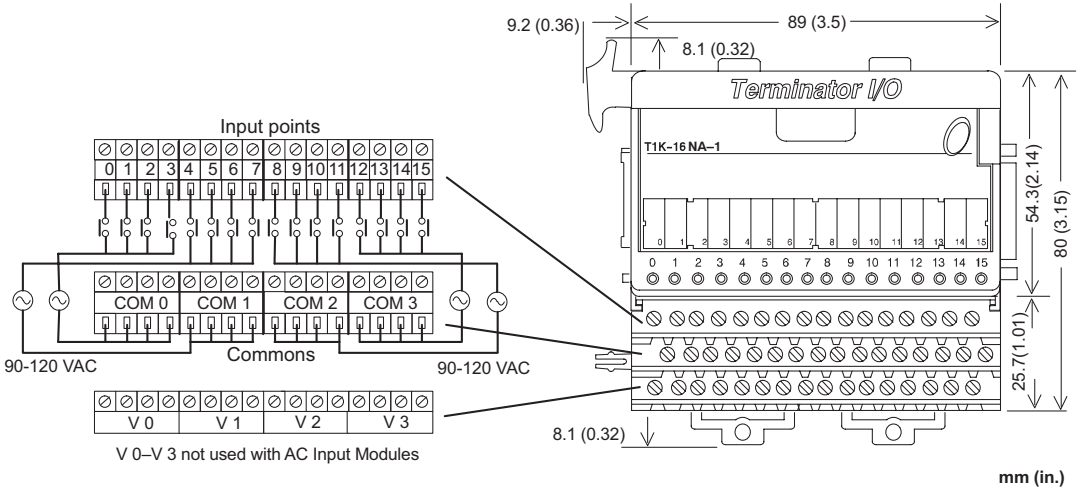


T1K-16NA-1 AC Input

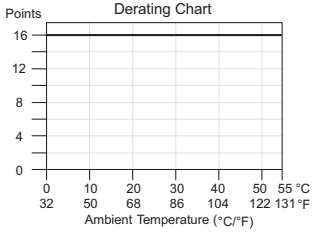
Specifications	
Inputs Per Module	16
Commons Per Module	4, 4 pts. / com. (isolated)
Operating Voltage	90 - 120 VAC, 47 - 63 Hz
Input Voltage Range	80 - 132 VAC, 47 - 63 Hz min. / max.
Input Current	8 mA @ 100 VAC (50 Hz) 10 mA @ 100 VAC (60 Hz) 12 mA @ 132 VAC (50 Hx) 15 mA @ 132 VAC (60 Hz)
Input Impedance	14 KΩ @ 50 Hz, 12 KΩ @ 60 Hz
ON Current / Voltage	> 6 mA @ 75 VAC
OFF Current / Voltage	< 2.0 mA @ 20 VAC
OFF to ON Response	< 40 ms
ON to OFF Response	< 40 ms
Base Power Requirements	70 mA @ 5 VDC
Status Indicators	Logic Side
Weight	120 g

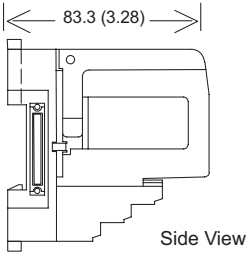
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions

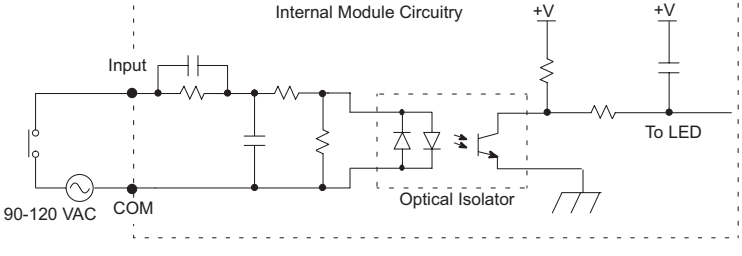


mm (in.)





Equivalent Input Circuit

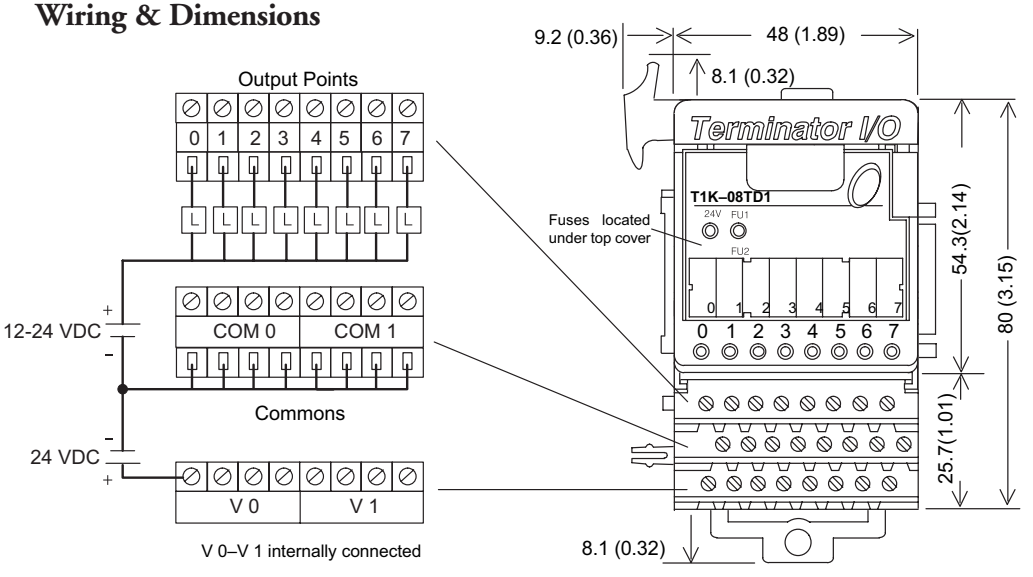


T1K-08TD1 DC Output

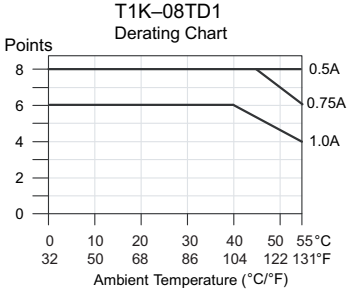
Specifications	
Outputs Per Module	8 (sink)
Commons Per Module	2 internally connected
Operating Voltage Range	6 - 27 VDC
Output Voltage Range	5 - 30 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μA @ 30 VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100 ms
OFF to ON Response	< 10 μs
ON to OFF Response	< 60 μs
Base Power Requirements	100 mA @ 5 VDC
External Power Required	200 mA max. @ 20 - 28 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	24 V ON = low external power FU1 / FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-1	2, (6.3 A, 250 V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	85 g

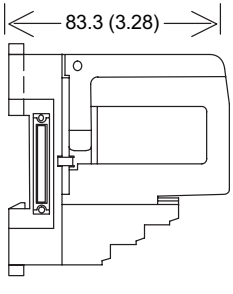
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions



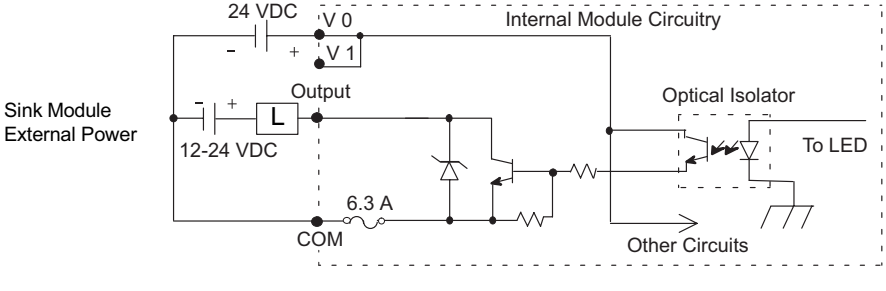
mm (in.)





Side View

Equivalent Output Circuit

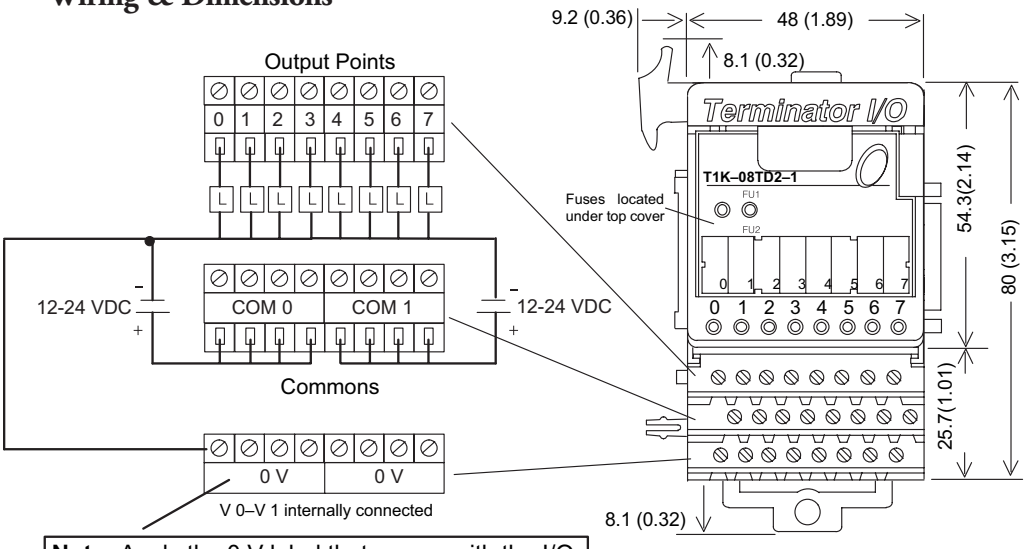


T1K-08TD2-1 DC Output

Specifications	
Outputs Per Module	8 (sourcing)
Commons Per Module	2 internally connected
Operating Voltage Range	12 - 24 VDC
Output Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μA @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0 A
Max. Inrush Current	2A for 100 ms
OFF to ON Response	< 10 μs
ON to OFF Response	< 0.5 ms
Base Power Requirements	100 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-1	2, (6.3 A, 250 V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	100 g

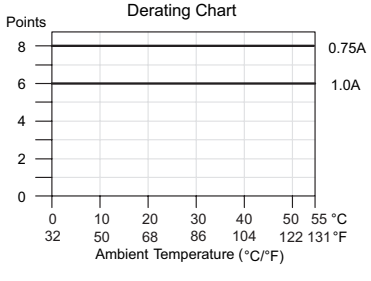
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

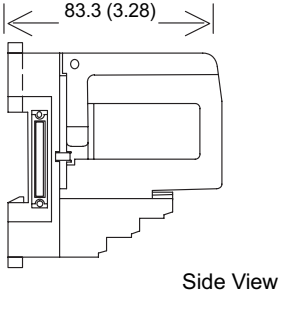
Wiring & Dimensions



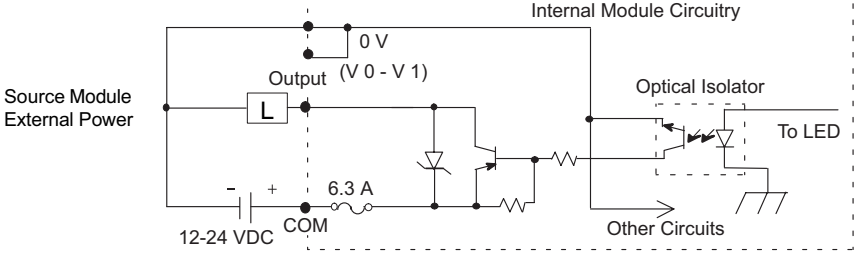
Note: Apply the 0 V label that comes with the I/O module to I/O base terminal points V 0–V 1 to properly identify the 0 VDC terminal points.

mm (in.)





Equivalent Output Circuit



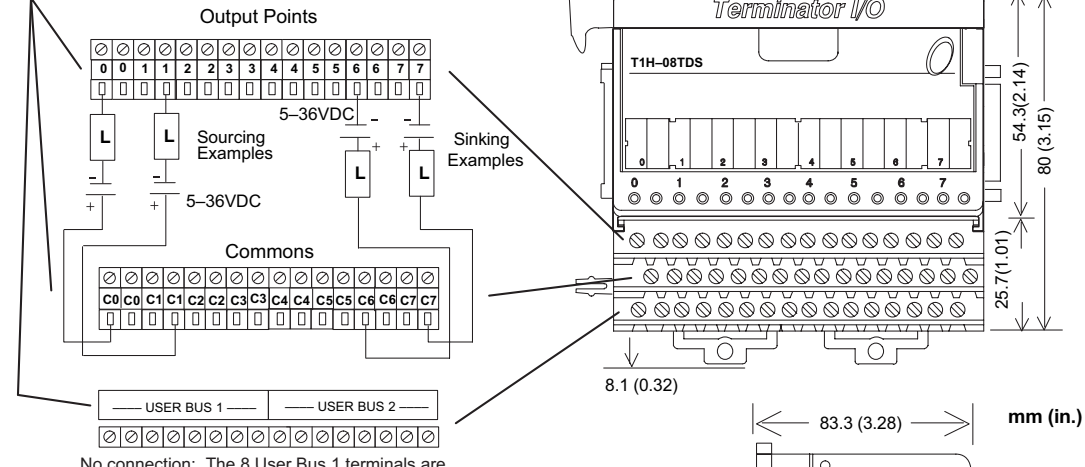
T1H-08TDS Isolated DC Output

Specifications	
Outputs Per Module	8 (isolated, sink / sourcing)
Commons Per Module	8 (isolated)
Operating Voltage Range	5 - 36 VDC
Max. Voltage	36 VDC
Output Clamp Voltage	40 VDC
Max. Load Current	2A / pt., 16 A / module, 32° F to 140° F (0° C to 60° C)
Electronic Over Current Protection	Output trips at 6 A min., 12 A max.
Max. Load Voltage	36 VDC
Max. Leakage Current	75 μA
Max. ON State Voltage Drop	0.3 VDC @ 2.0 A, 0.15 V @ 1 A
Inrush Current	5A for 20 ms
OFF to ON Response	< 3 μs
ON to OFF Response	< 100 μs
Base Power Requirements	200 mA max.
Thermal Shutdown	Between Tjunction = 302° F to 374° F (150° C to 190° C)
Over Temperature Reset	Thermal shutdown temp. minus 5° F (15° C)
Status Indicators	Logic Side
Weight	93.6 g

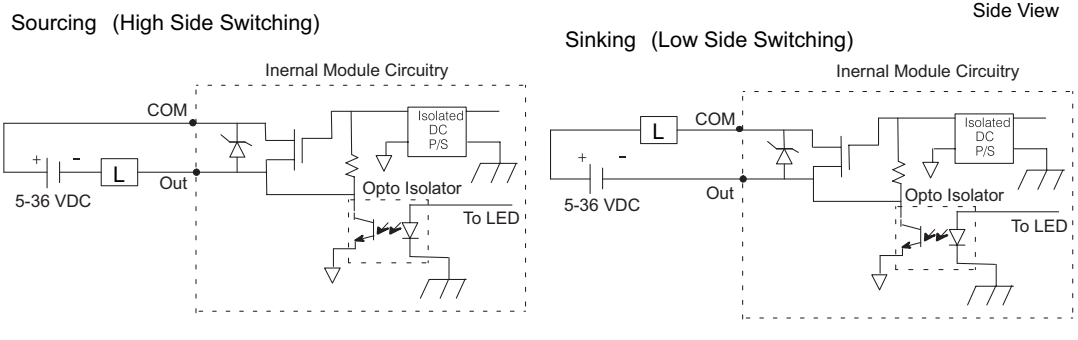
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions

Note: Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.



Equivalent Output Circuit

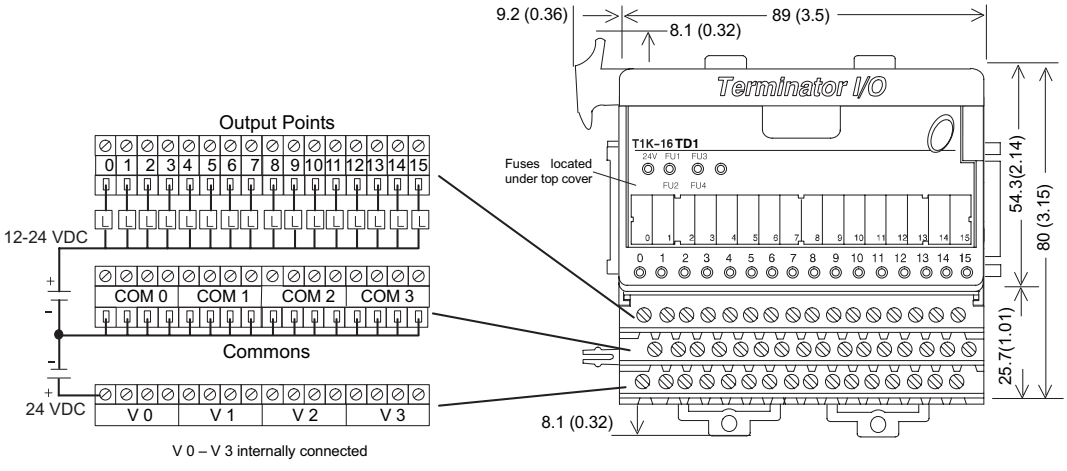


T1K-16TD1 DC Output

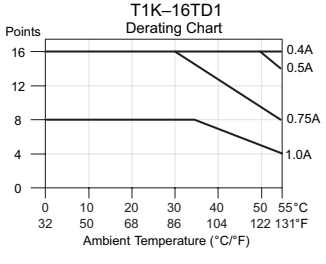
Specifications	
Outputs Per Module	16 (sink)
Commons Per Module	4 internally connected
Operating Voltage Range	6 - 27 VDC
Output Voltage Range	5 - 30 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μA @ 30 VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100 ms
OFF to ON Response	< 10 μs
ON to OFF Response	< 60 μs
Base Power Requirements	200 mA @ 5 VDC
External Power Required	400 mA max. @ 20 - 28 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	24 V ON = low external power FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-1	4, (6.3 A, 250 V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	140 g

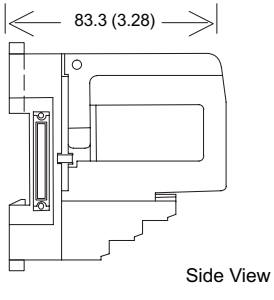
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions

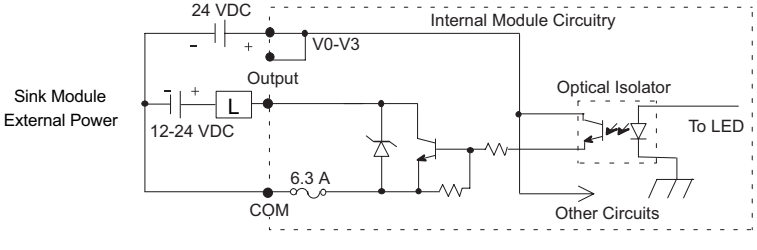


mm (in.)





Equivalent Output Circuit

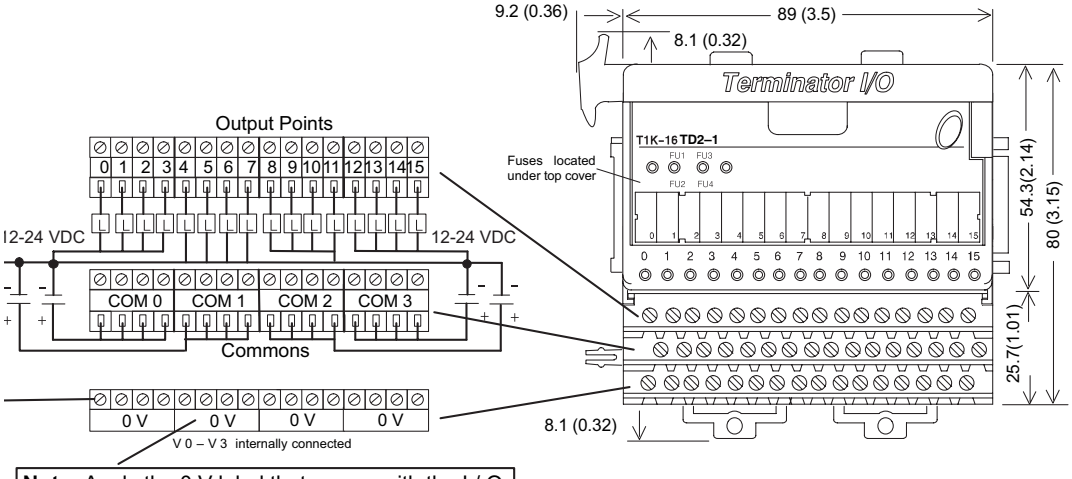


T1K-16TD2-1 DC Output

Specifications	
Outputs Per Module	16 (source)
Commons Per Module	4 internally connected
Operating Voltage Range	12 - 24 VDC
Output Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common (subject to derating)
Max. Leakage Current	15 μA @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0 A
Max. Inrush Current	2A for 100 ms
OFF to ON Response	< 10 μs
ON to OFF Response	< 0.5 ms
Base Power Requirements	200 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-1	4, (6.3 A, 250 V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	140 g

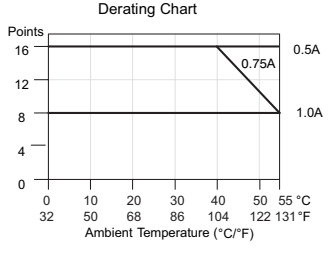
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

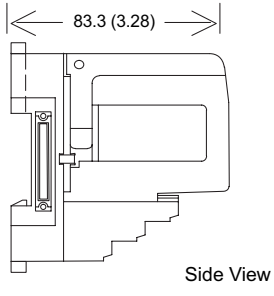
Wiring & Dimensions



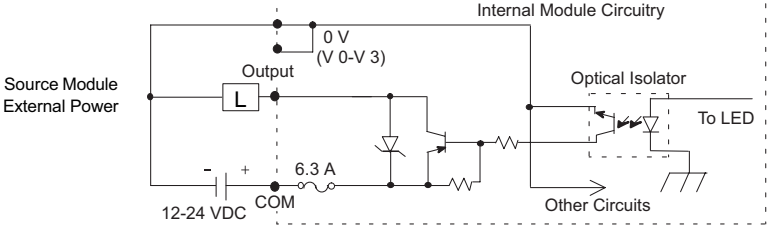
Note: Apply the 0 V label that comes with the I / O module to I / O base terminal points V 0–V 3 to properly identify the 0 VDC terminal points.

mm (in.)





Equivalent Output Circuit

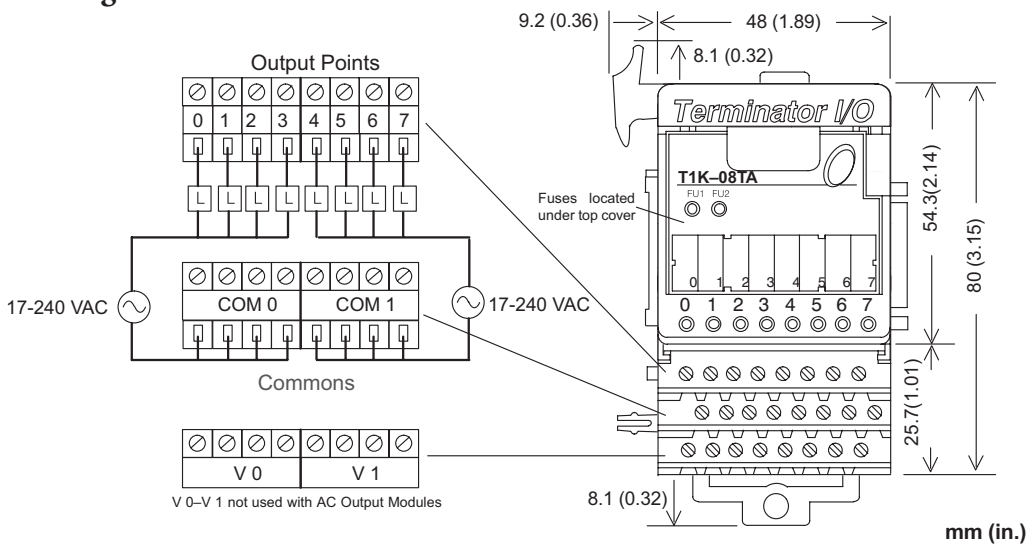


T1K-08TA AC Output

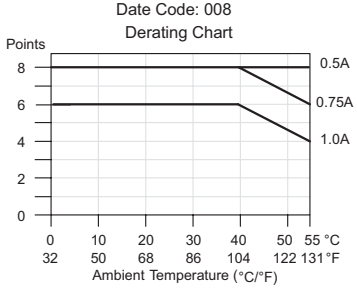
Specifications	
Outputs Per Module	8
Commons Per Module	2, 4 pts. / common (isolated)
Operating Voltage Range	17 - 240 VAC (47 - 63 Hz)
Output Voltage Range	15 - 264 VAC (47 - 63 Hz) min. / max.
Max. Load Current	1A / pt., 4A / common (subject to derating)
ON Voltage Drop	1.5 VAC @ > 50 mA, 4.0 VAC @ < 50 mA
Max. Leakage Current	4 mA @ 264 VAC
Max. Inrush Current	10 A for 10 ms
Min. Load	10 mA
OFF to ON Response	< 1 ms
ON to OFF Response	< 1 ms + 1/2 cycle
Base Power Requirements	250 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 ON = fuse 1 blown FU2 ON = fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-2	2, (10 A, 250 V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	140 g

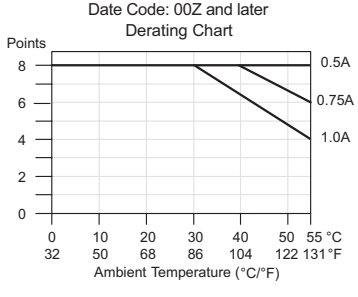
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

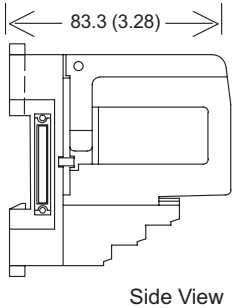
Wiring & Dimensions



mm (in.)

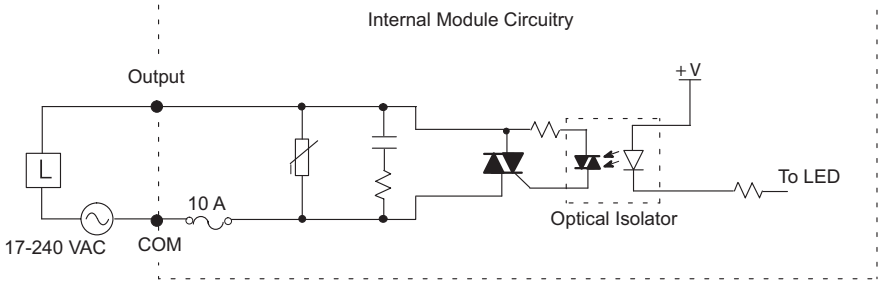






Side View

Equivalent Output Circuit

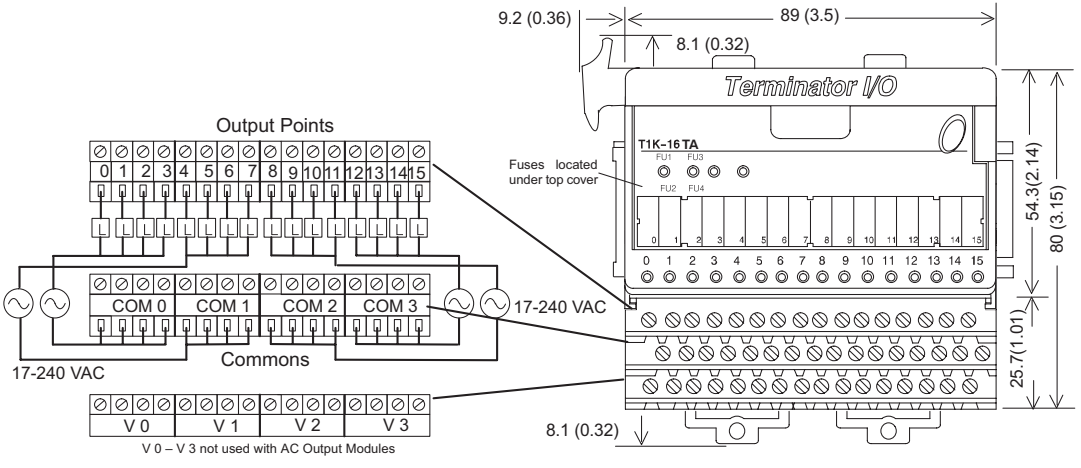


T1K-16TA AC Output

Specifications	
Outputs Per Module	16
Commons Per Module	4, 4 pts. / common (isolated)
Operating Voltage Range	17 - 240 VAC (47 - 63 Hz)
Output Voltage Range	15 - 264 VAC (47 - 63 Hz) min. / max.
Max. Load Current	1A / pt., 4A / common (subject to derating)
ON Voltage Drop	1.5 VAC @ > 50 mA, 4.0 VAC @ < 50 mA
Max. Leakage Current	4 mA @ 264 VAC
Max. Inrush Current	10 A for 10 ms
Min. Load	10 mA
OFF to ON Response	< 1 ms
ON to OFF Response	< 1 ms + 1/2 cycle
Base Power Requirements	450 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-2	4, (10 A, 250 V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	190 g

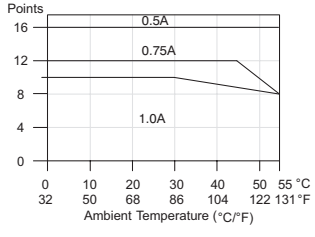
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

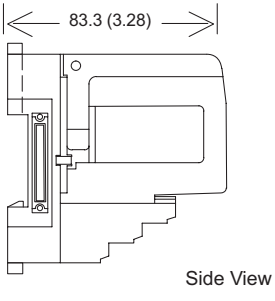
Wiring & Dimensions



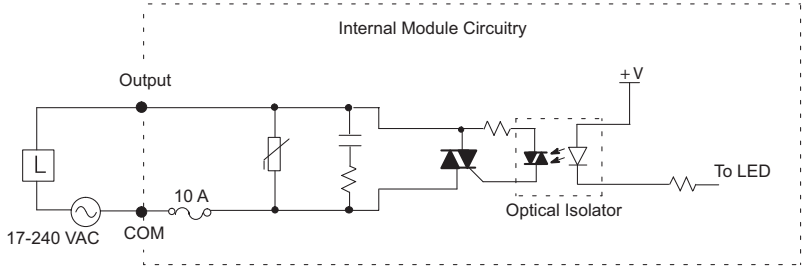
mm (in.)

Date Code: 012 and Later
Derating Chart





Equivalent Output Circuit



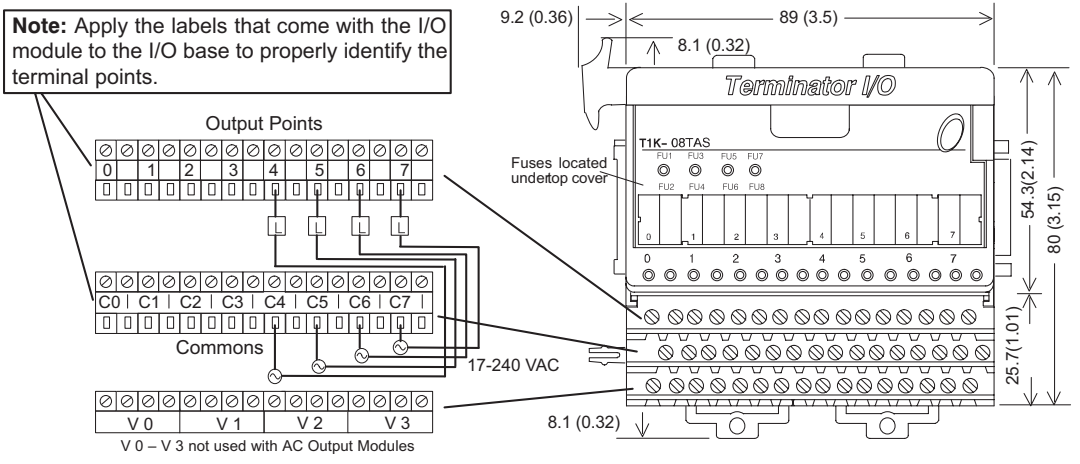
T1K-08TAS AC Output

Specifications	
Outputs Per Module	8
Commons Per Module	8, 1 pt. / common (isolated)
Operating Voltage Range	17 - 240 VAC (47 - 63 Hz)
Output Voltage Range	15 - 264 VAC (47 - 63 Hz) min. / max.
Max. Load Current	2A / pt. common (subject to derating)
ON Voltage Drop	1.5 VAC @ > 50 mA, 4.0 VAC @ < 50 mA
Max. Leakage Current	4 mA @ 264 VAC
Max. Inrush Current	10 A for 10 ms
Min. Load	10 mA
OFF to ON Response	< 1 ms
ON to OFF Response	< 1 ms + 1/2 cycle
Base Power Requirements	300 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown FU5 / FU6 ON = fuse 5 or 6 blown FU7 / FU8 ON = fuse 7 or 8 blown
Fuses (User Replaceable) T1K-FUSE-3	8 (10 A, 250 V / common), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	190 g

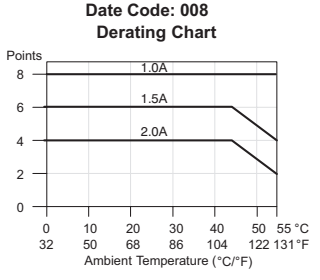
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

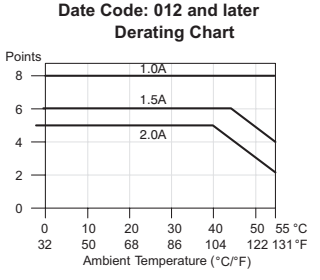
Wiring & Dimensions

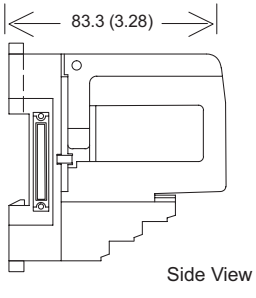
Note: Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.



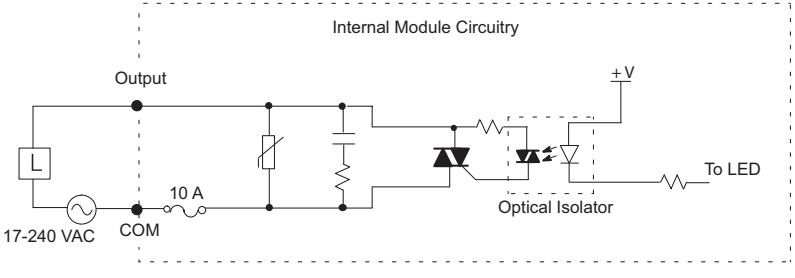
mm (in.)







Equivalent Output Circuit

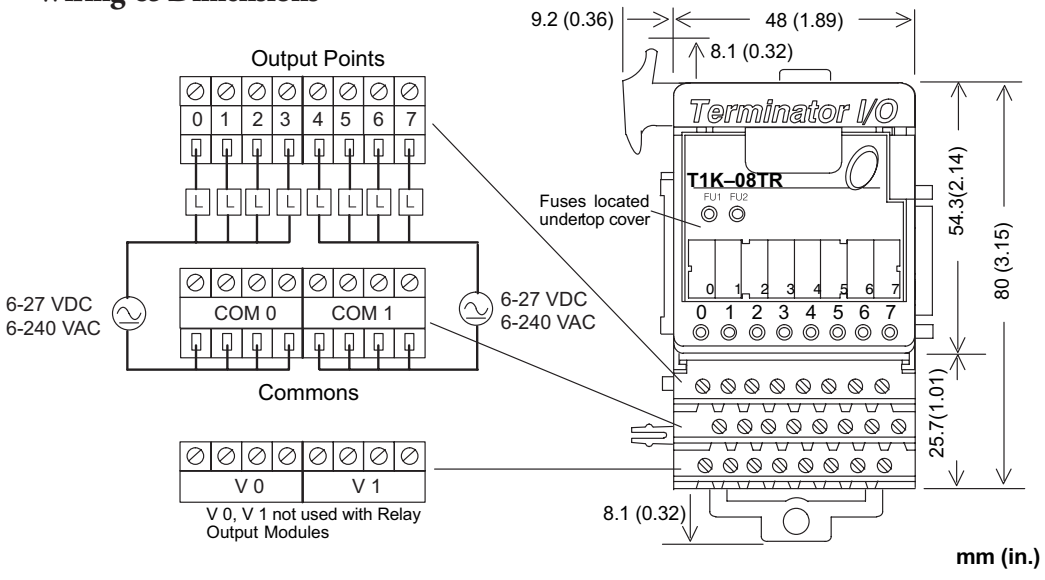


T1K-08TR Relay Output

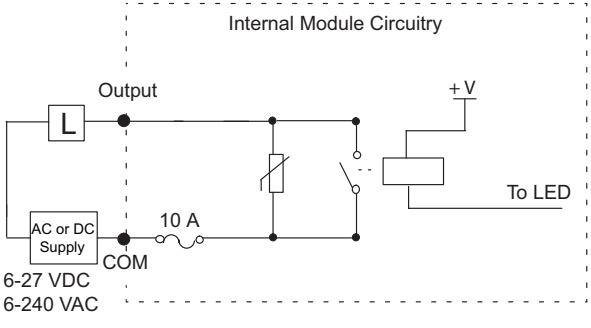
Specifications	
Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	2, 4 pts. / common (isolated)
Operating Voltage Range	6 - 240 VAC (47 - 63 Hz), 6 - 27 VDC
Output Voltage Range	5 - 264 VAC (47 - 63 Hz) min. / max. 5 - 30 VDC min / max
Max. Load Current	2A / pt., 8A / common
Max. Leakage Current	0.1 mA @ 264 VAC
Max. Inrush Current	6A for 10 ms. / pt.; 20 A for 10 ms / common
Min. Load	5 mA @ 5 VDC
OFF to ON Response	< 15 ms
ON to OFF Response	< 10 ms
Base Power Requirements	350 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 ON = fuse 1 blown FU2 ON = fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-2	2 (10 A, 250 V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	110 g

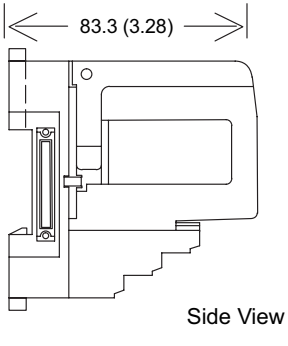
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions

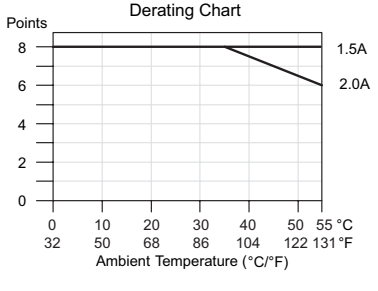


Equivalent Output Circuit





Typical Relay Life (Operations) at Room Temperature		
Voltage & Type of Load	Load Current	
	1 A	2 A
24 VDC Resistive	500 K	250 K
24 VDC Solenoid	100 K	50 K
110 VAC Resistive	500 K	250 K
110 VAC Resistive	200 K	100 K
220 VAC Resistive	350 K	200 K
220 VAC Resistive	100 K	50 K

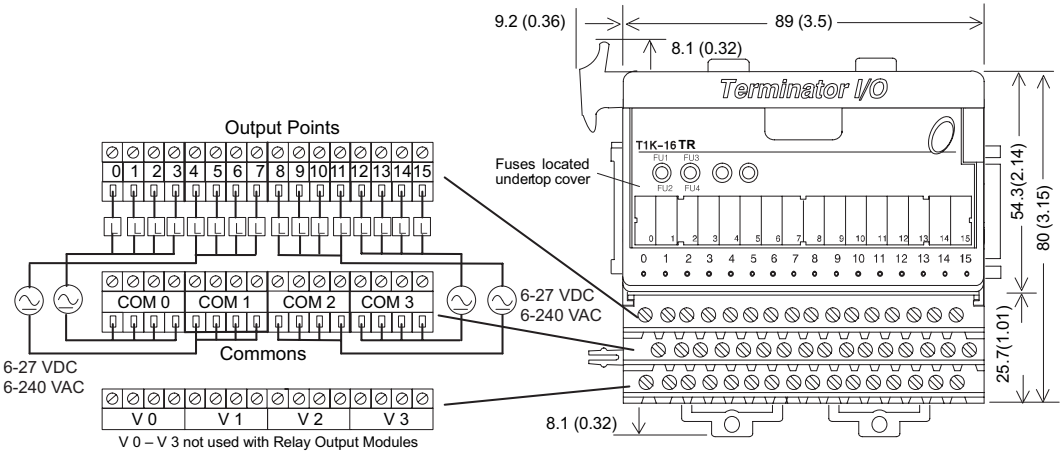


T1K-16TR Relay Output

Specifications	
Outputs Per Module	16
Output Type	Relay Form A (SPST) normally open
Commons Per Module	4, 4 pts. / common (isolated)
Operating Voltage Range	6 - 240 VAC (47 - 63 Hz), 6 - 27 VDC
Output Voltage Range	5 - 264 VAC (47 - 63 Hz) min. / max. 5 - 30 VDC min / max
Max. Load Current	2A / pt., 6 A / common
Max. Leakage Current	0.1 mA @ 264 VAC
Max. Inrush Current	6A for 10 ms / pt.; 20 A for 10 ms / common
Min. Load	5 mA @ 5 VDC
OFF to ON Response	< 15 ms
ON to OFF Response	< 10 ms
Base Power Requirements	700 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or fuse 2 blown FU3 / FU4 ON = fuse 3 or fuse 4 blown
Fuses (User Replaceable) T1K-FUSE-2	4 (10 A, 250 V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	200 g

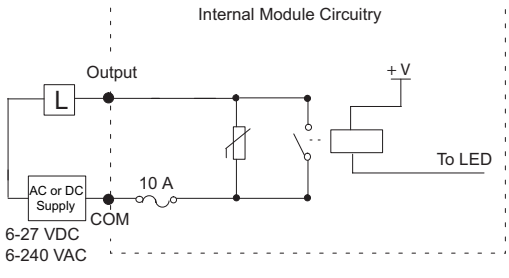
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

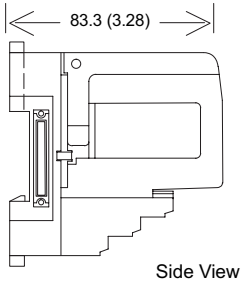
Wiring & Dimensions



mm (in.)

Equivalent Output Circuit

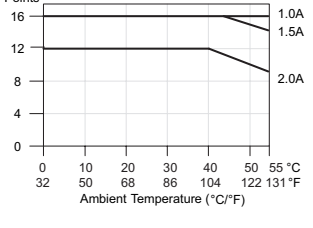




Typical Relay Life (Operations) at Room Temperature		
Voltage & Type of Load	Load Current	
	1 A	2 A
24 VDC Resistive	500 K	250 K
24 VDC Solenoid	100 K	50 K
110 VAC Resistive	500 K	250 K
110 VAC Resistive	200 K	100 K
220 VAC Resistive	350 K	200 K
220 VAC Resistive	100 K	50 K

Date Code: 012* and later

Derating Chart

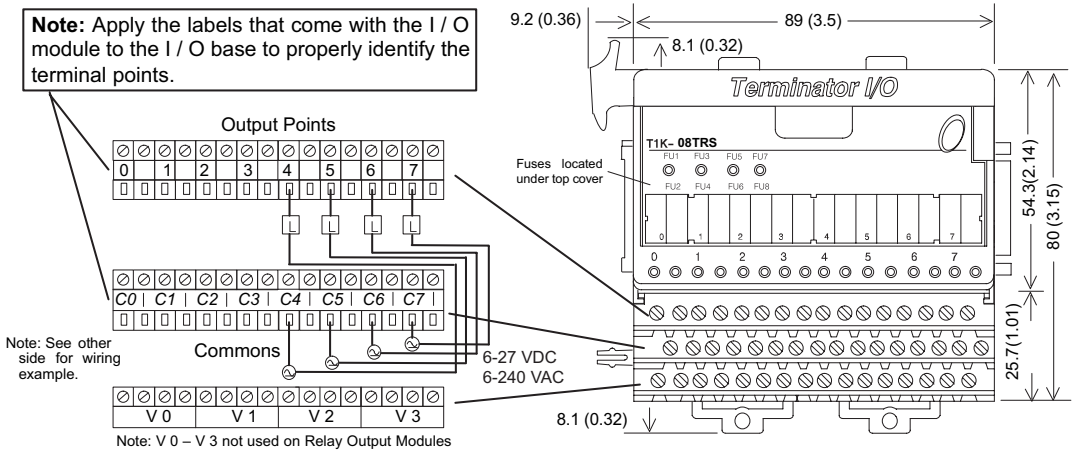


T1K-08TRS Relay Output

Specifications	
Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	8, 1 pt. / common (isolated)
Operating Voltage Range	6 - 240 VAC (47 - 63 Hz), 6 - 27 VDC
Output Voltage Range	5 - 264 VAC (47 - 63 Hz) min. / max. 5 - 30 VDC min. / max.
Max. Load Current	7A / pt. common (subject to derating)
Max. Leakage Current	0.1 mA @ 264 VAC
Max. Inrush Current	8A for 10 ms
Min. Load	5 mA @ 5 VDC
OFF to ON Response	< 15 ms
ON to OFF Response	< 10 ms
Base Power Requirements	400 mA @ 5 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown FU5 / FU6 ON = fuse 5 or 6 blown FU7 / FU8 ON = fuse 7 or 8 blown
Fuses (User Replaceable) T1K-FUSE-3	8 (10 A, 250 V / common), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	185 g

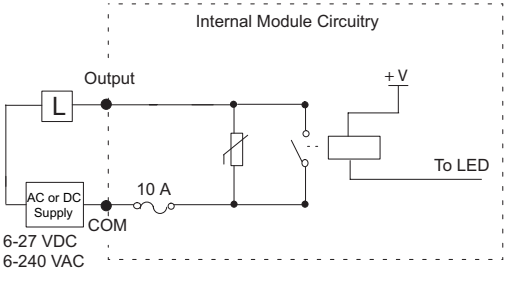
Environmental Specifications	
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000 V FCC class A RFI (144 MHz, 430 MHz 10 W, 10 cm)
Agency Approvals	UL, CE, FCC class A

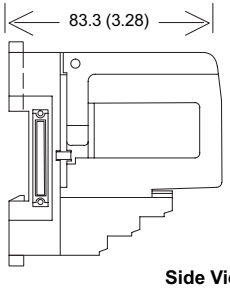
Wiring & Dimensions


Note: Apply the labels that come with the I / O module to the I / O base to properly identify the terminal points.
Output Points
0 1 2 3 4 5 6 7
C0 C1 C2 C3 C4 C5 C6 C7
Commons
Note: See other side for wiring example.
V 0 V 1 V 2 V 3
Note: V 0 – V 3 not used on Relay Output Modules
6-27 VDC
6-240 VAC
Fuses located under top cover
T1K– 08TRS
9.2 (0.36)
89 (3.5)
8.1 (0.32)
Terminator I/O
54.3(2.14)
80 (3.15)
25.7(1.01)
8.1 (0.32)

mm (in.)

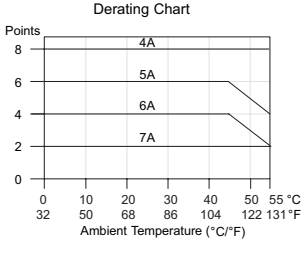
Equivalent Output Circuit





Side View

Typical Relay Life (Operations) at Room Temperature				
Voltage & Type of Load	Load Current			
	1 A	2 A	5 A	7 A
24 VDC Resistive	1000 K	500 K	200 K	100 K
24 VDC Solenoid	300 K	100 K	**	**
110 VAC Resistive	1000 K	500 K	200 K	100 K
110 VAC Resistive	300 K	100 K	**	**
220 VAC Resistive	500 K	250 K	125 K	60 K
220 VAC Resistive	300 K	100 K	**	**



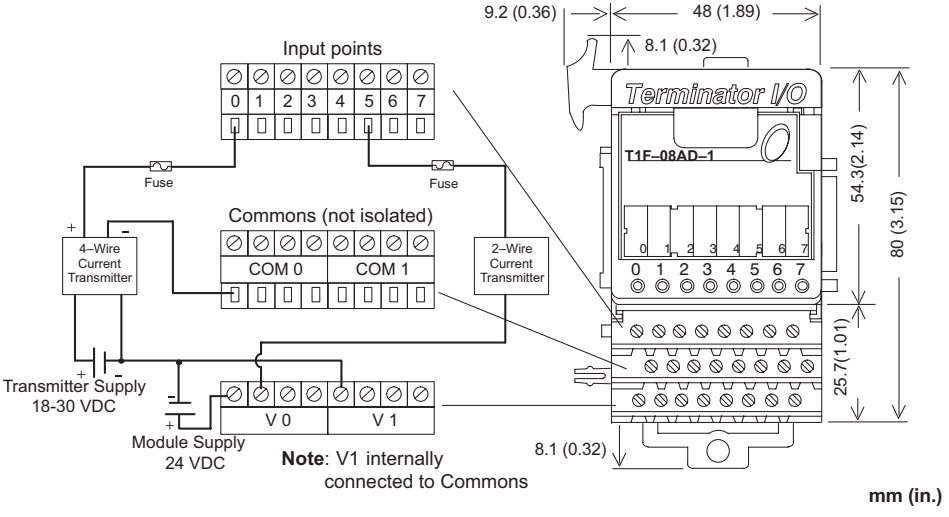
**Solenoid (inductive) loads > 2A cannot be used.

T1F-08AD-1 - 8 Channel Current Analog Input

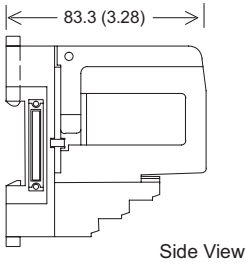
Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0 - 20 mA, 4 - 20 mA, - 20 to 20 mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3 db @ 500 Hz, - 20 db / decade
Input Resistance	250 Ω
Absolute Maximum Ratings	8V max. Input
Conversion Time (Default: Normal Mode)	Normal Mode: 5 ms per channel Fast Mode: 0.5 ms per channel (Fast Mode supported in module hardware version B or later, and only when using this analog module with the T1H-EBC(100) or T1H-PBC control module)
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.18% @ 25° C 0.36% @ 60° C
Master Update Rate	8 channels per scan max.
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	18 - 30 VDC, 50 mA, class 2
Recommended Fuse	0.032 A @ 5 VDC, Series 217 Fast Acting
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	136 g

Input Range Resolution	
-20 to 20 mA	-8192 to 8191 counts
0 - 20 mA	0 - 8191 counts
4 - 20 mA	1638 - 8191 counts

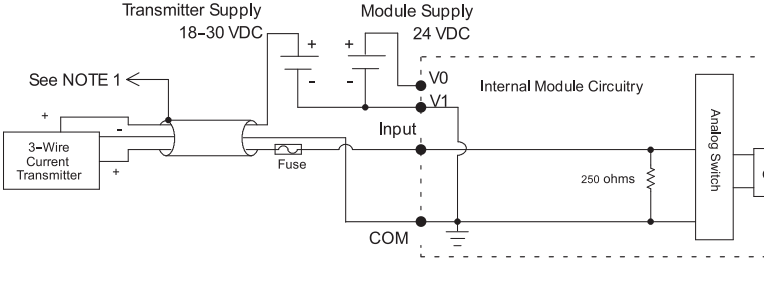
Wiring & Dimensions



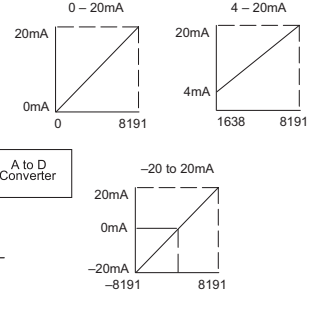
NOTES:
1. Shields should be grounded at the signal source.
2. More than one external power supply can be used, provided all the power supply commons are connected.
3. A Series 217, 0.032 A fast-acting fuse is recommended for 4–20 mA current loops.
4. If the power supply common of an external power supply is not connected to the 0V terminal on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4–20 mA transmitter types are:
– For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.
– For 4 wire connections: Isolation between the input supply signal, the power supply and the 4–20 mA output.



Equivalent Input Circuit



Input Signal Ranges

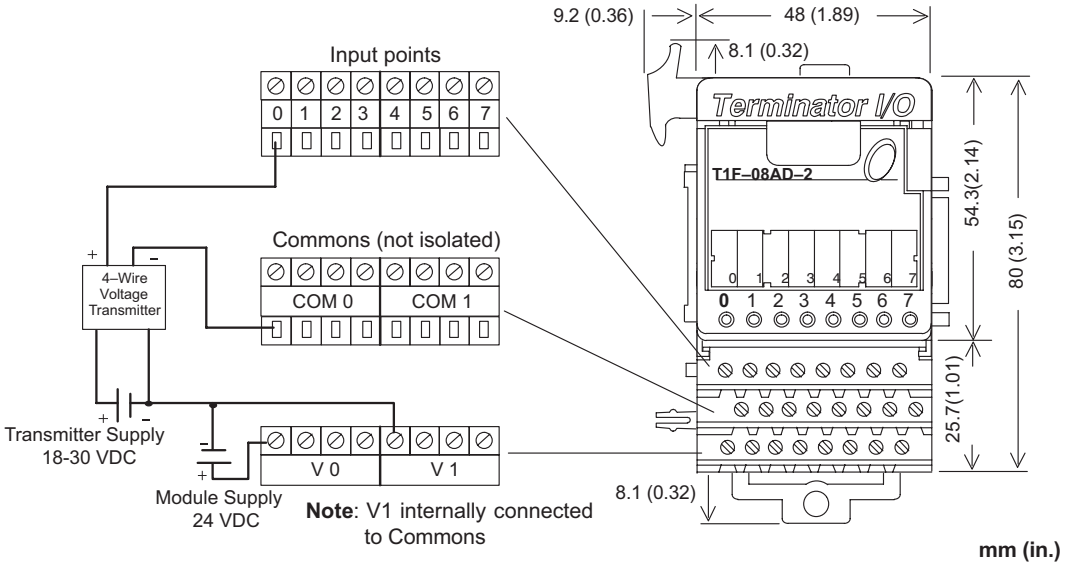


T1F-08AD-2 - 8 Channel Voltage Analog Input

Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3 db @ 500 Hz, - 20 db / decade
Input Resistance	200 KΩ min.
Absolute Maximum Ratings	Fault Protected Input, 130 V (rms) or 100 VDC
Conversion Time (Default: Normal Mode)	Normal Mode: 5 ms per channel Fast Mode: 0.5 ms per channel (Fast Mode supported in module hardware version B or later, and only when using this analog module with the T1H-EBC(100) or T1H-PBC control module)
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25° C 0.26% @ 60° C
Master Update Rate	8 channels per scan max.
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	18 - 30 VDC, 50 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	136 g

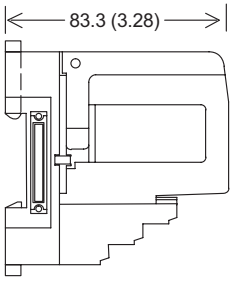
Input Range Resolution	
0 - 5 V	0 - 4095 counts
0 - 10 V	0 - 8191 counts
+ / - 5 V	- 4095 to 4095 counts
+ / - 10 V	-8192 to 8191 counts

Wiring & Dimensions

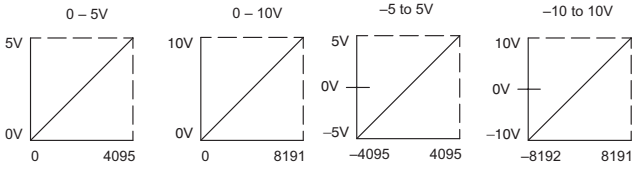


mm (in.)

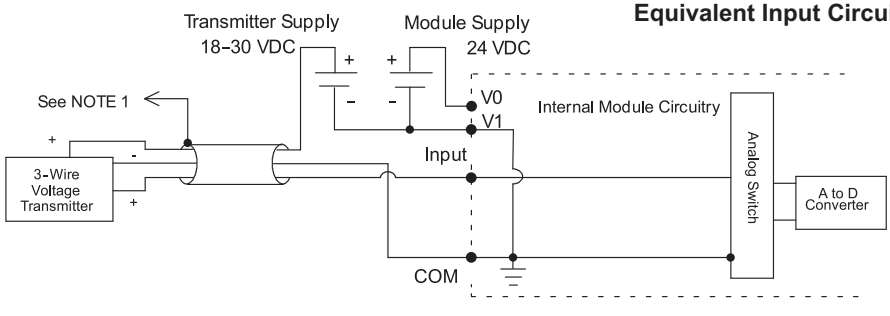
NOTES:
1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. More than one external power supply can be used, provided all the power supply commons are connected.



Input Signal Ranges



Equivalent Input Circuit

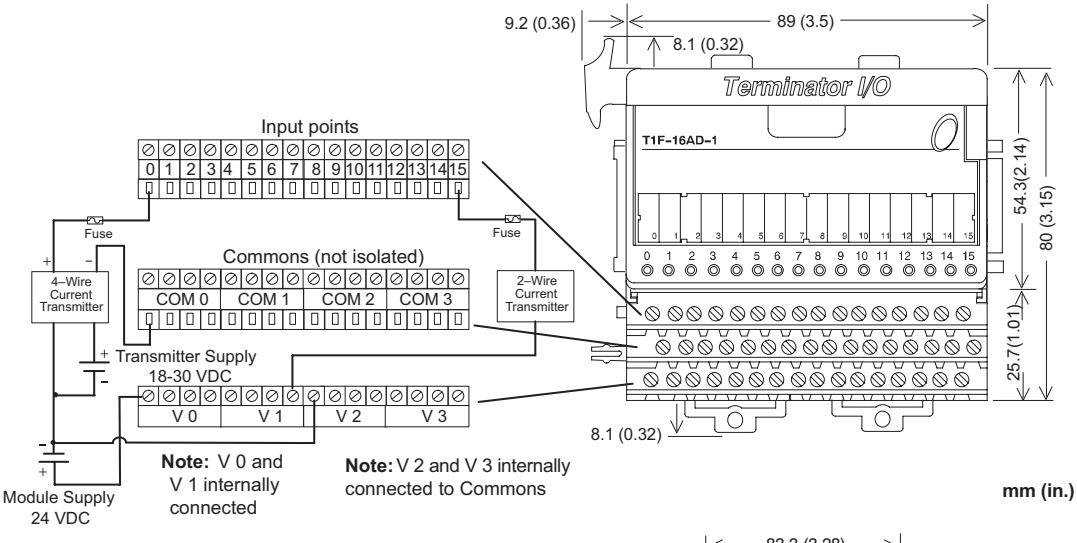


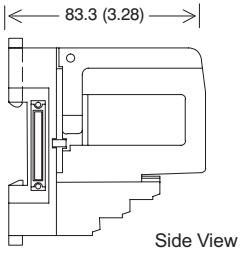
T1F-16AD-1 - 16 Channel Current Analog Input

Specifications	
Number of Channels	16, single ended (1 common)
Input Ranges	0 - 20 mA, 4 - 20 mA, - 20 to 20 mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3 db @ 500 Hz, - 20 db / decade
Input Resistance	250 Ω
Absolute Maximum Ratings	8V max. Input
Conversion Time	5 ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.18% @ 25° C 0.36% @ 60° C
Master Update Rate	16 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	18 - 30 VDC, 50 mA, class 2
Recommended Fuse	0.032 A @ 5 VDC
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168 g

Input Range Resolution	
-20 to 20 mA	-8192 to 8191 counts
0 - 20 mA	0 - 8191 counts
4 - 20 mA	1638 - 8191 counts

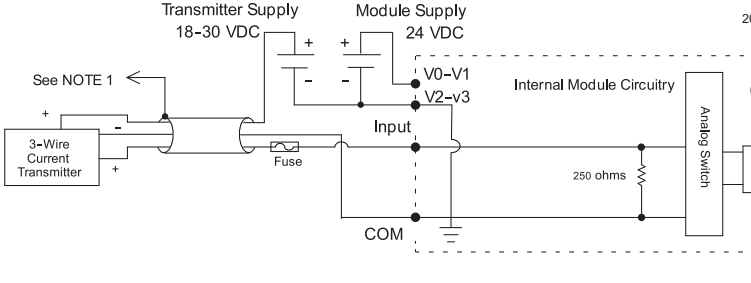
Wiring & Dimensions



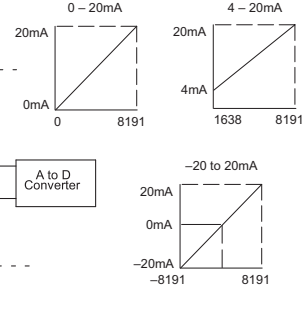


NOTES:
1. Shields should be grounded at the signal source.
2. More than one external power supply can be used, provided all the power supply commons are connected.
3. A Series 217, 0.032 A fast-acting fuse is recommended for 4–20 mA current loops.
4. If the power supply common of an external power supply is not connected to the 0 V terminal on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4–20 mA transmitter types are:
– For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.
– For 4 wire connections: Isolation between the input supply signal, the power supply and the 4–20 mA output.

Equivalent Input Circuit



Input Signal Ranges

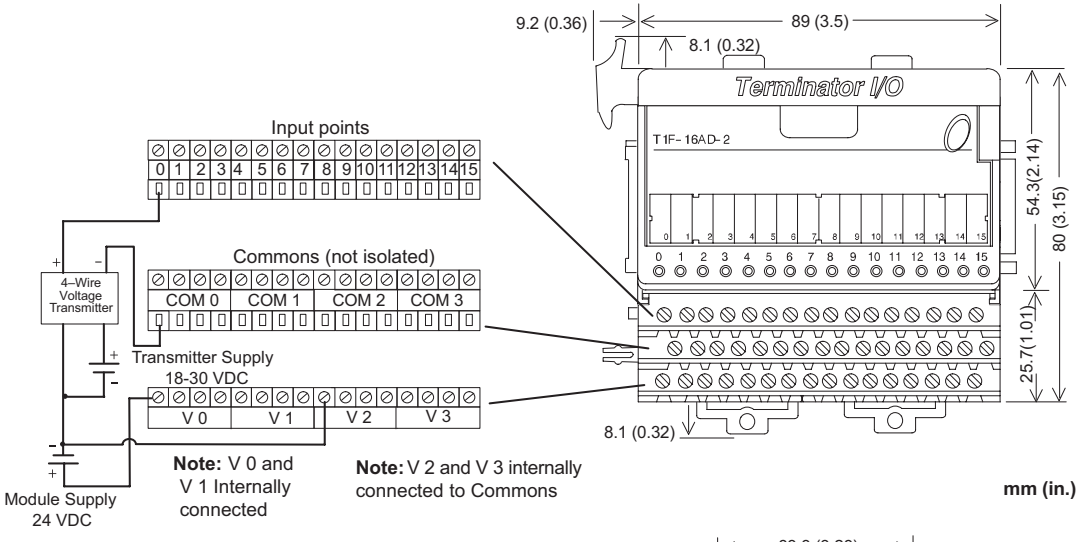


T1F-16AD-2 16 Channel Voltage Analog Input

Specifications	
Number of Channels	16, single ended (1 common)
Input Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3 db @ 500 Hz, - 20 db / decade
Input Resistance	200 KΩ min.
Absolute Maximum Ratings	Fault Protected Input, 130 V (rms) or 100 VDC
Conversion Time	5 ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25° C 0.26% @ 60° C
Master Update Rate	16 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	21.6 - 26.4 VDC, 50 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	160 g

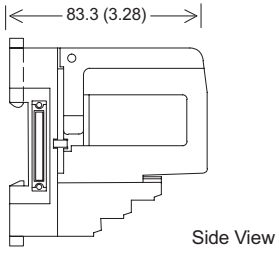
Input Range Resolution	
0 - 5 V	0 - 4095 counts
0 - 10 V	0 - 8191 counts
+ / - 5 V	- 4095 to 4095 counts
+ / - 10 V	-8192 to 8191 counts

Wiring & Dimensions

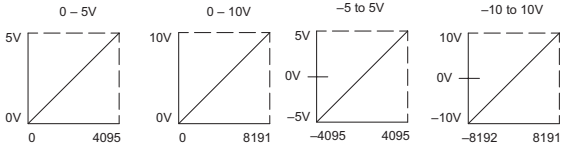

9.2 (0.36)
89 (3.5)
8.1 (0.32)
Terminator I/O
T1F-16AD-2
54.3(2.14)
80 (3.15)
25.7(1.01)
8.1 (0.32)
Input points
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Commons (not isolated)
COM 0 COM 1 COM 2 COM 3
V 0 V 1 V 2 V 3
4–Wire Voltage Transmitter
Transmitter Supply 18-30 VDC
Module Supply 24 VDC
Note: V 0 and V 1 Internally connected
Note: V 2 and V 3 internally connected to Commons

mm (in.)

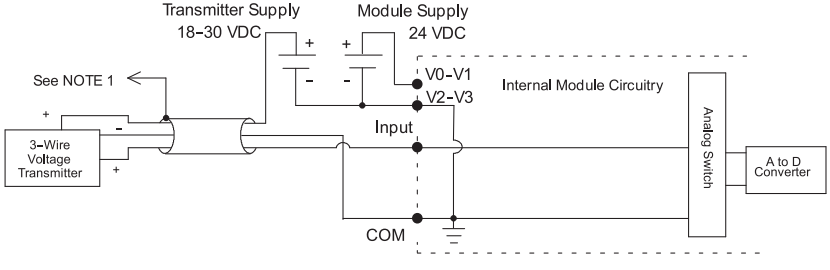
NOTES:
1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. More than one external power supply can be used, provided all the power supply commons are connected.



Input Signal Ranges



Equivalent Input Circuit



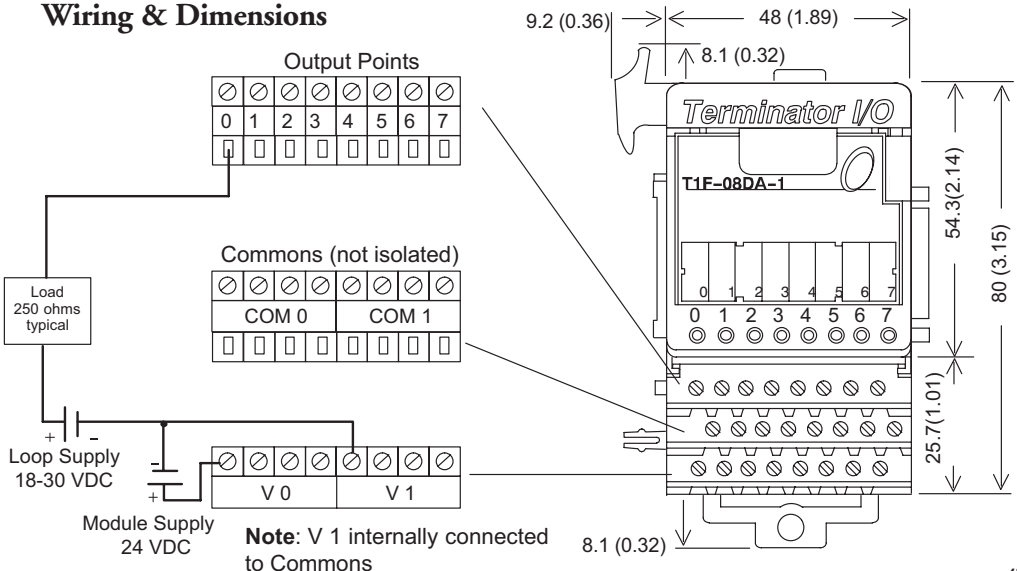
T1F-08DA-1 8 Channel Current Analog Output

Specifications	
Number of Channels	8
Output Ranges	0 - 20 mA, 4 - 20 mA
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30 VDC
Peak Output Voltage	30 VDC
Load Impedance	0Ω min.
Max. Load (ohm) / Power Supply	620 / 18 V, 910 / 24 V, 1200 / 30 V
Min. Load (ohm) / Power Supply*	0 / 24 V, 350 / 30 V @ 40° C 250 / 24 V, 600 / 30 V @ 60° C
Linearity Error (end to end)	+ / - 2 counts max. + / - 0.05% of full scale max.
Conversion Settling Time	400 μs max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	0 - 20 mA: + / - 5 counts max. 4 - 20 mA: + / - 6 counts max.
Accuracy vs. Temperature	+ / - 50 ppm / ° C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.2% @ 25° C 0.4% @ 60° C
Master Update Rate	8 channels per scan max.
Output Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	21.6 - 26.4 VDC, 150 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	145 g

*Max. allowable output power dissipation. For example, at 60° C and 24 VDC, there must be a load of at least 250 Ω on the output circuit. Smaller loads will damage the analog output circuit.

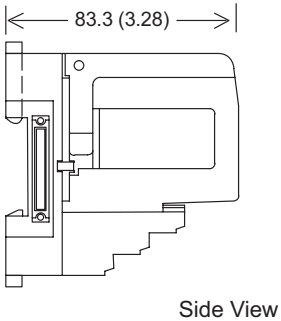
NOTE: *This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.*

Wiring & Dimensions



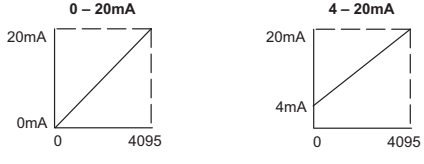
mm (in.)

NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.
2. Unused current outputs should remain open (no connections) for minimum power consumption.

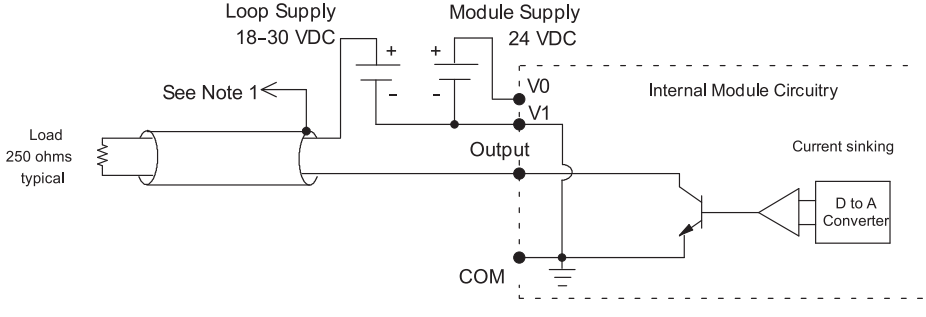


Side View

Output Signal Ranges



Equivalent Output Circuit

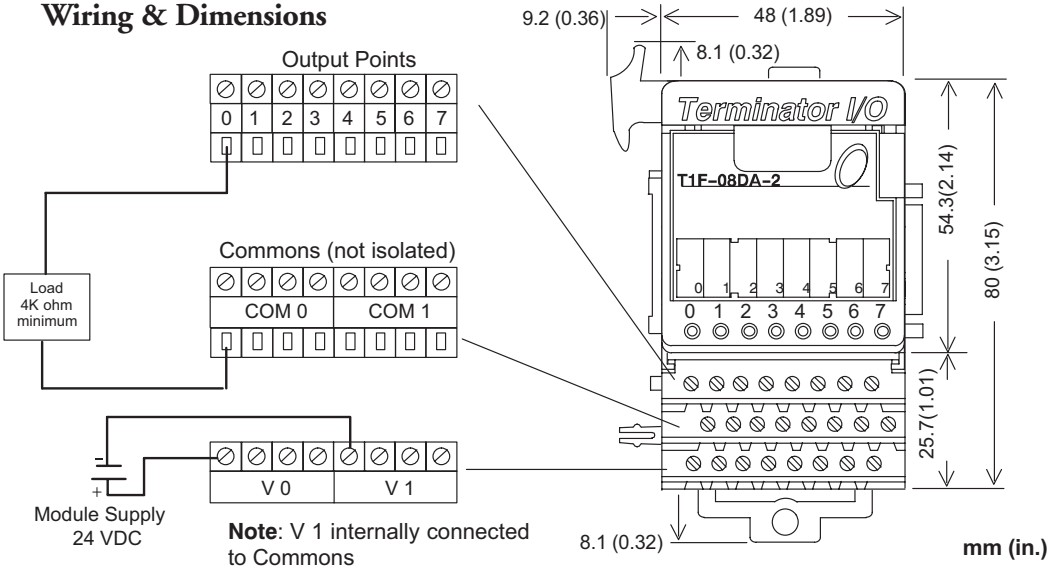


T1F-08DA-2 8 Channel Analog Output

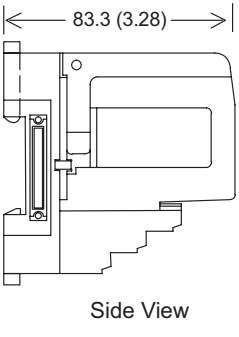
Specifications	
Number of Channels	8
Output Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4 KΩ min.
Load Capacitance	0.01 μF max.
Linearity Error (end to end)	+ / - 2 counts max. + / - 0.05% of full scale max.
Conversion Settling Time	100 μs max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	10 V ranges: + / - 6 counts max. 5 V ranges: + / - 11 counts max.
Accuracy vs. Temperature	+ / - 50 ppm / ° C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10 V ranges: + / - 0.2% @ 25° C + / - 0.4% @ 60° C 5 V ranges: + / - 0.3% @ 25° C + / - 0.5% @ 60° C
Master Update Rate	8 channels per scan max.
Output Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	21.6 - 26.4 VDC, 150 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	145 g

NOTE: *This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.*

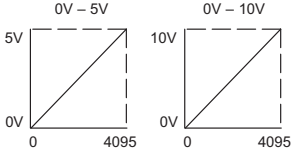
Wiring & Dimensions



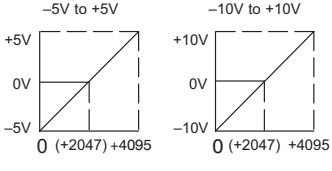
NOTES:
1. Shields should be connected to the 0 V terminal of the module ot the 0 V terminal of the power supply.
2. Unused voltage outputs should remain open (no connections) for minimum power consumption.



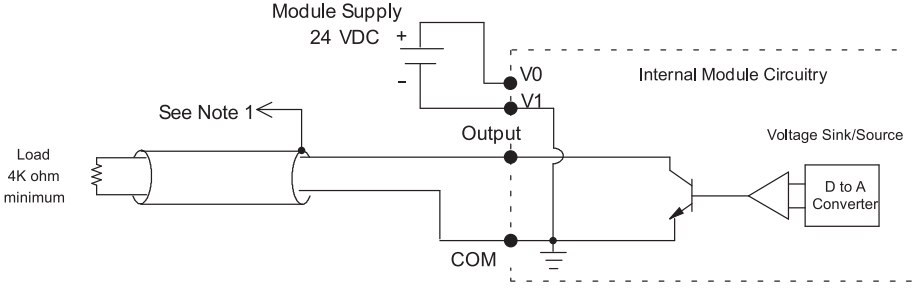
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



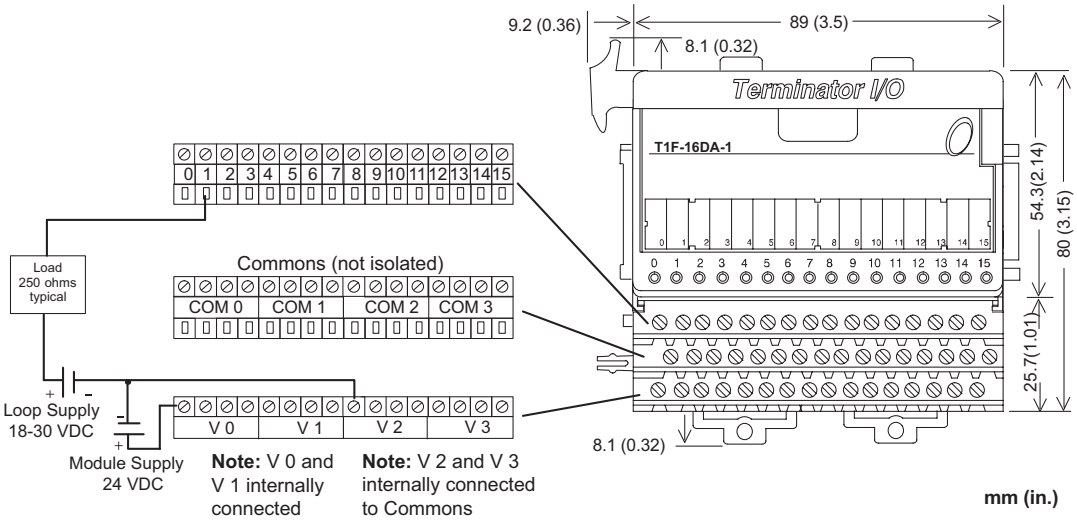
T1F-16DA-1 16 Channel Current Analog Output

Specifications	
Number of Channels	16
Output Ranges	0 - 20 mA, 4 - 20 mA
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30 VDC
Peak Output Voltage	30 VDC
Max. Load (ohm) / Power Supply	620 / 18 V, 910 / 24 V, 1200 / 30 V
Min. Load (ohm) / Power Supply*	0 / 24 V, 350 / 30 V @ 40° C 250 / 24 V, 600 / 30 V @ 60° C
Linearity Error (end to end)	+ / - 2 counts max. + / - 0.05% of full scale max.
Conversion Settling Time	400 μs max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	0 - 20 mA: + / - 5 counts max. 4 - 20 mA: + / - 6 counts max.
Accuracy vs. Temperature	+ / - 50 ppm / ° C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.2% @ 25° C 0.4% @ 60° C
Master Update Rate	16 channels per scan max.
Output Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	21.6 - 26.4 VDC, 150 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	172 g

*Max. allowable output power dissipation. For example, at 60° C and 24 VDC, there must be a load of at least 250 Ω on the output circuit. Smaller loads will damage the analog output circuit.

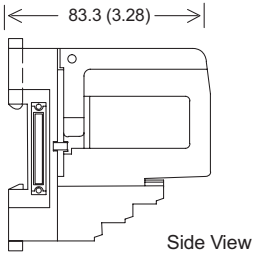
NOTE: *This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.*

Wiring & Dimensions

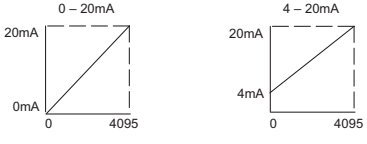


mm (in.)

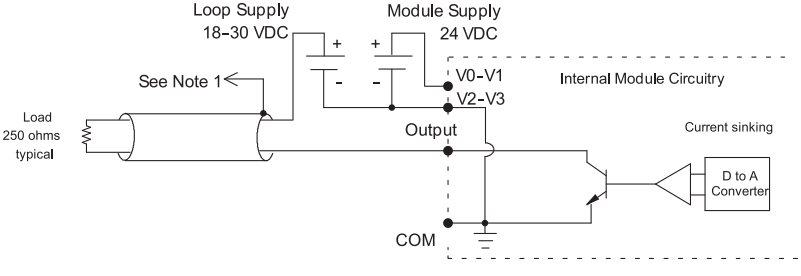
NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.
2. Unused current outputs should remain open (no connections) for minimum power consumption.



Output Signal Ranges



Equivalent Output Circuit

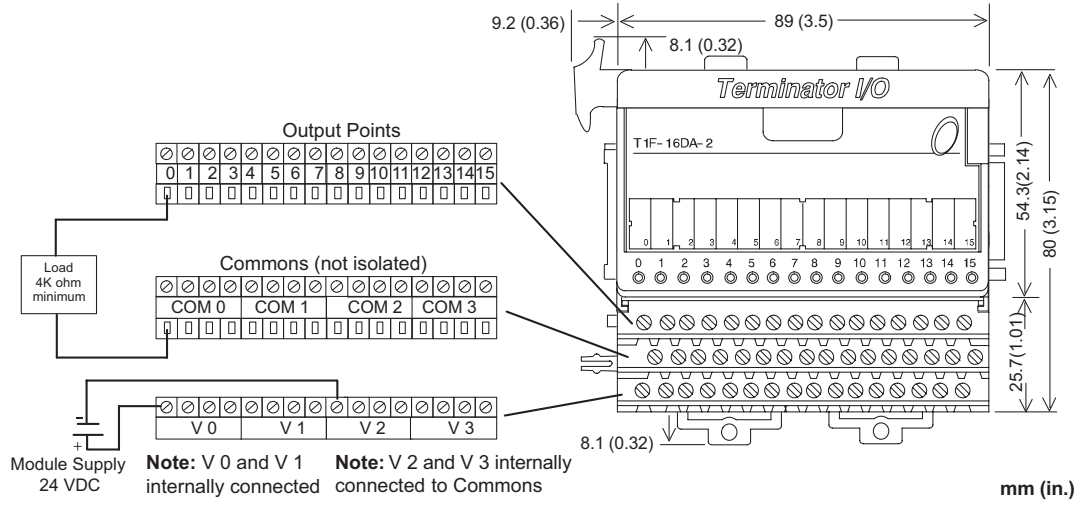


T1F-16DA-2 16 Channel Voltage Analog Output

Specifications	
Number of Channels	16
Output Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4 KΩ min.
Load Capacitance	0.01 μF max.
Linearity Error (end to end)	+ / - 2 counts max. + / - 0.05% of full scale max.
Conversion Settling Time	100 μs max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	10 V ranges: + / - 6 counts max. 5 V ranges: + / - 11 counts max.
Accuracy vs. Temperature	+ / - 50 ppm / ° C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10 V ranges: + / - 0.2% @ 25° C + / - 0.4% @ 60° C 5 V ranges: + / - 0.3% @ 25° C + / - 0.5% @ 60° C
Master Update Rate	16 channels per scan max.
Output Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply Req.	21.6 - 26.4 VDC, 150 mA, class 2
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	172 g

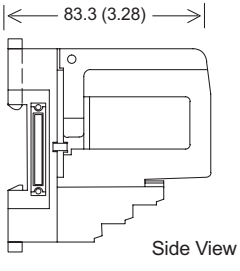
NOTE: *This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.*

Wiring & Dimensions

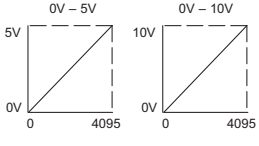


mm (in.)

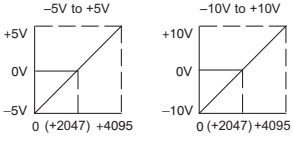
NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.
2. Unused voltage outputs should remain open (no connections) for minimum power consumption.



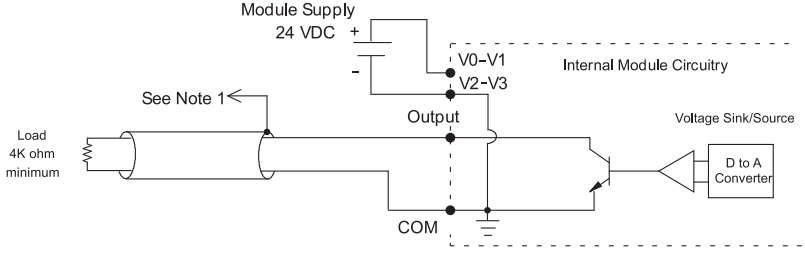
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



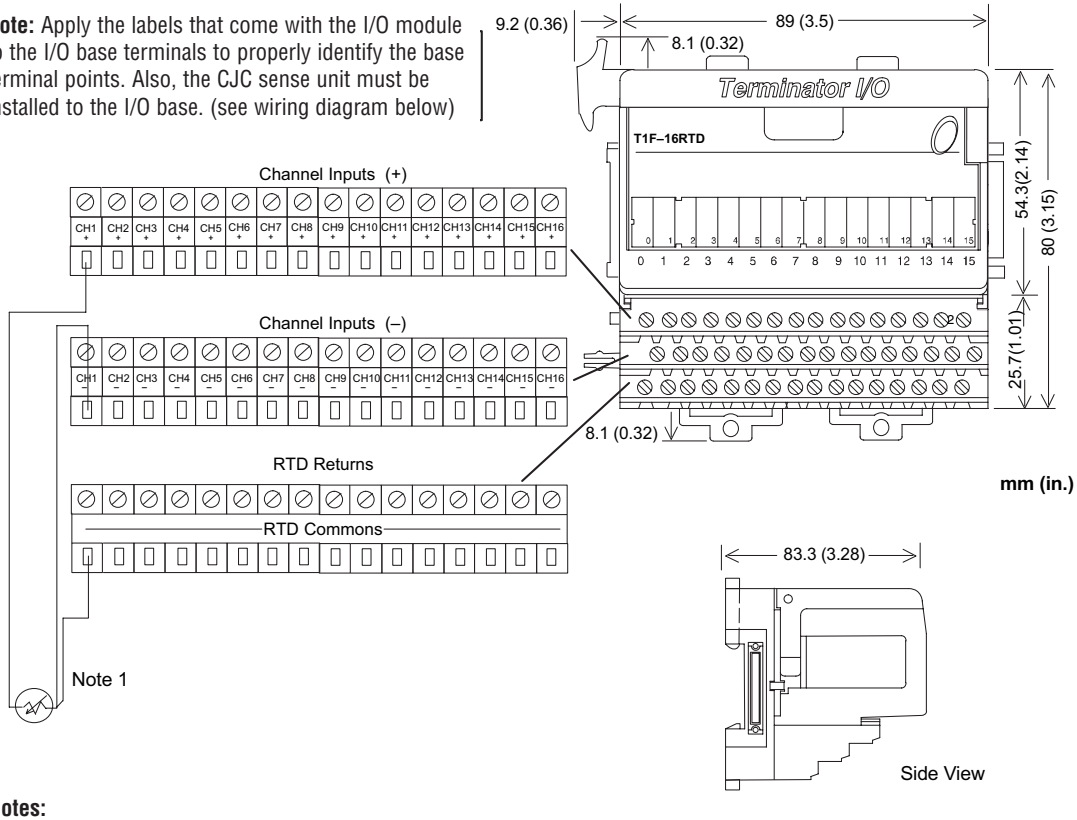
T1F-16RTD RTD Input Module

Specifications	
Number of Channels	16
Resolution	+ / - 0.1° C or ° F
Common Mode Range	0 - 5 VDC
Notch Filter	> 50 db notches @ 50 / 60 Hz; f - 3 db = 13.1 Hz
Absolute Max. Ratings	+ / - 50 VDC
Converter Type	Charge balancing, 24 - bit
Sampling Rate	140 ms / channel
Master Update Rate	16 channels per scan
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	150 mA @ 5 VDC
Operating Temperature	0° to 60° C (32° to 140° F)
Temperature Drift	25 ppm / ° C (max.)
Maximum Inaccuracy	+ / - 1° C
RTD Excitation Current	200 μA
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168 g

RTD Input Ranges	
RTD Type	**Range**
Pt100	-200° to 850° C (-328° to 1562° F)
Pt1000	-200° to 595° C (-328° to 1103° F)
jPt100	- 38° to 450° C (-36° to 842° F)
Type CU - 10 / 25	-200° to 260° C (-328° to 500° F)
120 Ω Nickel	-80° to 260° C (-112° to 500° F)

Wiring & Dimensions

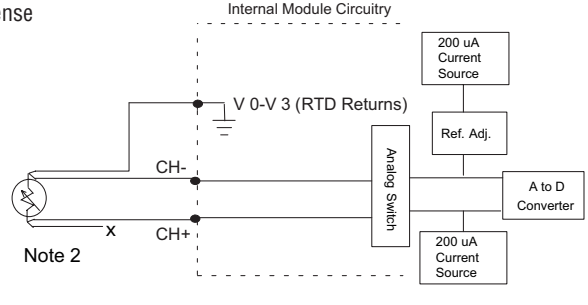
Note: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points. Also, the CJC sense unit must be installed to the I/O base. (see wiring diagram below)



Notes:

1. The three wires connecting the RTD to the module must be the same type and length. Do not use the shield or drain wire for the third connection.
2. If an RTD sensor has four wires, the plus sense wireshould be left unconnected as shown.

Equivalent Input Circuit



T1F-16RTD continued

Setting Module Jumpers

Select Input Type (see Note 1)

Number of Channels	Jumper			
	CH+1	CH+2	CH+3	CH+4
1				
2	X			
3		X		
4	X	X		
5			X	
6	X		X	
7		X	X	
8	X	X	X	
9				X
10	X			X
11		X		X
12	X	X		X
13			X	X
14	X		X	X
15		X	X	X
16	X	X	X	X

X = Jumper Installed

Blank Space = Jumper Removed

Select Number of Channels (see Note 2)

RTD Input	Jumper		
	RTD-0	RTD-1	RTD-2
Pt100 Ω	X	X	
Pt1000 Ω			X
jPt100 Ω		X	
Type CU-10 Ω			
Type CU-25 Ω	X		
120 Ω Nickel	X		X

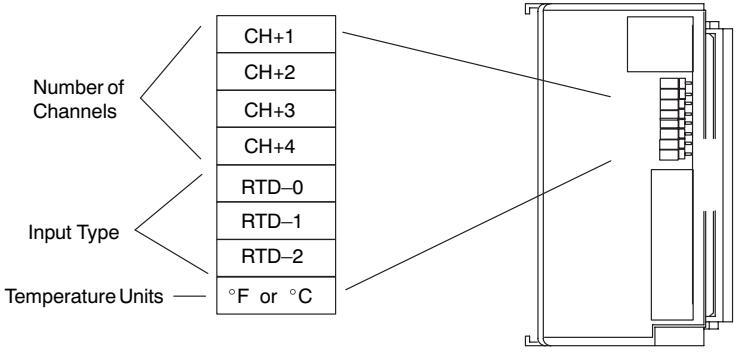
X = Jumper Installed

Blank Space = Jumper Removed

NOTE 1: *The module comes from the factory with all of the Number of Channels jumbers installed for sixteen channel operation. Use the table to determine the proper settings.*

NOTE 2: *The module comes from the factory with the input Type jumpers selected for Pt100 Ω operation. Use the table to determine the proper settings.*

Jumpers Located Under Module Top Cover



Select Temperature Units

Temperature Units	Jumper
°F	X
°C	

X = Jumper Installed,
Blank Space = Jumper Removed

T1F-RTD Data Format

The data format for each of the 16 RTD input channels consists of 32 bits. Only one bit is used in bits D31 - D16 (bit 24) as shown below.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	**B0**	-	-	-	-	-	-	-	-

Bit 24, designated as B0, is the channel burn out bit:

1 = channel RTD sensor burn out or RTD is disconnected from either input terminal

0 = channel is okay.

The remaining bits are not used and are all equal to 0 (-).

D15 - D0, shown below, contains the temperature data with D15 being the most significant bit (MSB). The temperature data has one implied decimal, so the readings are in tenths of degrees. Negative temperature readings are represented in 2's complement format.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

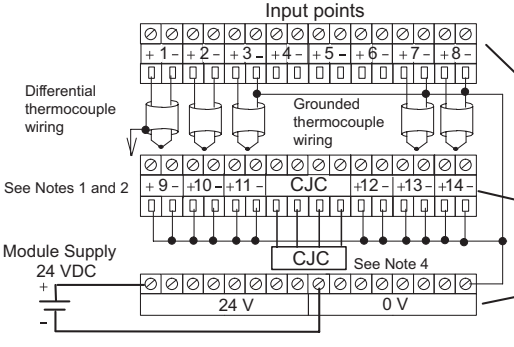
T1F-14THM 14 Channel Thermocouple Input

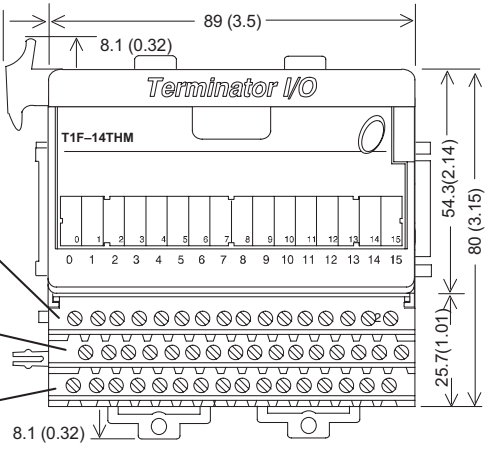
Specifications	
Use with I/O Module Base	T1K-16B screw type terminal base only
Number of Channels	14, differential
Common Mode Range	+ / - 5 VDC
Common Mode Rejection	90 db min. @ DC, 150 db min . @ 50 / 60 Hz
Input Impedance	1 MΩ
Absolute Max. Ratings	Fault Protected Input + / - 50 VDC
Master Update Rate	14 channels per scan maximum
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	60 mA @ 5 VDC
External Power Required	24 VDC +/- 5%, 70 mA, class 2
Operating Temperature	0° to 60° C (-4° to 158° F)
Storage Temperature	-20° to 70° C (32° to 140° F)
Accuracy vs. Temperature	+ / - 5 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168 g

Thermocouple Specifications	
Input Ranges	Type J -190° to 760° C (-310° to 1400° F) Type E -210° to 1000° C (-346° to 1832° F) Type K -150° to 1372° C (-238° to 2502° F) Type R 65° to 1768° C (149° to 3214° F) Type S 65° to 1768° C (149° to 3214° F) Type T -230° to 400° C (-382° to 752° F) Type B 529° to 1820° C (984° to 3308° F) Type N -70° to 1300° C (-94° to 2372° F) Type C 65° to 2320° C (149° to 4208° F)
Display Resolution	+ / - 0.1° C or + / - 0.1° F
Cold Junction Compensation (CJC Part #: T1F-CJC)	automatic
Conversion Time	100 ms per channel
Warm Up Time	30 minutes typical, + / - 1° C repeatability
Linearity Error	+ / - 0.05° C maximum, + / - 0.01° C typical
Maximum Inaccuracy	+ / - 3° C

Wiring & Dimensions

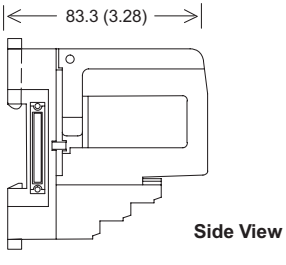
Note: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points. Also, the CJC sense unit must be installed to the I/O base (see wiring diagram below).



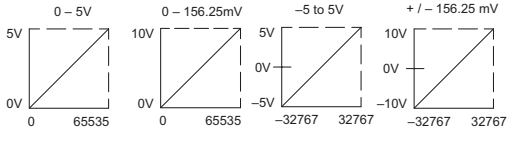


mm (in.)

NOTES:
1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. When using 0–156 mV and 5 V ranges, connect (–) or 0 V terminals to 0V to ensure common mode range acceptance
4. The Cold Junction Compensation (part #: T1F–CJC) temperature sense unit that comes with the module must be installed into the I/O base terminals to perform CJC of the thermocouple inputs.

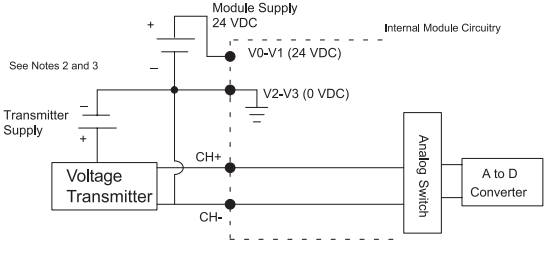


Voltage Input Signal Ranges



Voltage Specifications	
Input Voltage Ranges	0 - 5 V, 0 - 156.25 mV + / - 5 V, + / - 156.25 mV
Resolution	16 bit (1 in 65535)
Full Scale Calibration Error (Offset Error Included)	+ / - 13 counts typical + / - 33 countx maximum
Offset Calibration Error	+ / - 1 count max. @ 0 V input
Linearity Error (End to End)	+ / - 1 count maximum
Maximum Inaccuracy	+ / - 0.02% @ 25° C (77° F)

Equivalent Input Circuit



T1F-14THM continued

Setting Module Jumpers

Select Input Type (see Note 3)

Thermocouple/ Voltage Inputs	Jumper			
	T/C Type 0	T/C Type 1	T/C Type 2	T/C Type 3
J	X	X	X	X
K		X	X	X
E	X		X	X
R			X	X
S	X	X		X
T		X		X
B	X			X
N				X
C	X	X	X	
0 - 5 V		X	X	
± 5 V	X		X	
0 - 156 mV			X	
± 156 mV	X	X		

Select the Conversion Units

Jumper	Thermocouple Conversion Units (See Note 4)			
	Magnitude Plus Sign		2's Complement	
	°F	°C	°F	°C
Units-0	X		X	
Units-1	X	X		

Jumper	Voltage Conversion Units (See Note 5)	
	Magnitude Plus Sign	2's Complement
Units-0	X	X
Units-1	X	

X = Jumper Installed
Blank Space = Jumper Removed

T1F-THM Data Format

The data format for each of the 14 thermocouple input channels consists of 32 bits (shown here split into two groups of 16 bits). Only one bit is used in bits D31 - D16 (bit 24) as shown below.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	**BO**	-	-	-	-	-	-	-	-

Bit 24, designated as B0, is the channel burn out bit:

1 = channel thermocouple sensor burn out or thermocouple is disconnected from either input terminal

0 = channel is okay.

The remaining bits are not used and are all equal to 0 (-).

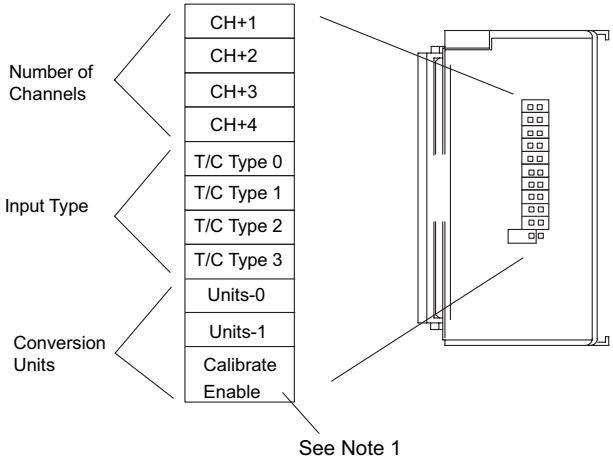
D15 to D0, shown below, contains the 16-bit temperature data with D15 being the most significant bit (MSB). See Notes 4 and 5.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Select Number of Channels (see Note 2)

Number of Channels	Jumper			
	CH+1	CH+2	CH+3	CH+4
1				
2	X			
3		X		
4	X	X		
5			X	
6	X		X	
7		X	X	
8	X	X	X	
9				X
10	X			X
11		X		X
12	X	X		X
13			X	X
14	X		X	X

Jumpers Located Under Module Top Cover



NOTES

Note 1: The Calibrate Enable jumper comes from the factory not installed. Installing the jumper disables the thermocouple active burn-out detection circuitry, which enables a thermocouple calibrator to be connected to the module. To make sure that the output of the thermocouple calibrator is within the 5 V common mode voltage range of the module, connect the negative side of the differential voltage input channel to the 0 V terminal, then connect the thermocouple calibrator to the differential inputs (for example, Ch 3+ and Ch 3-).

Note 2: The module comes with all of the Number of Channels jumpers installed for fourteen channel operation. Use the table to determine the proper settings.

Note 3: The module comes with all of the Input Type jumpers installed for J type thermocouple operation. Use the table to determine the proper settings.

Note 4: The module comes with the Conversion Units jumpers set for magnitude plus sign with Fahrenheit units selected. All thermocouple types are converted into a direct temperature reading with one implied decimal place. Negative temperatures can be represented in either 2's complement or magnitude plus sign format. If the temperaure is negative, the most significant bit is the sign bit. 2's complement data format may be required to correctly display bipolar data on some operator interfaces.

Note 5: The bipolar voltage input ranges may be converted to a 15–bit magnitude plus sign or a 16–bit 2's complement value.

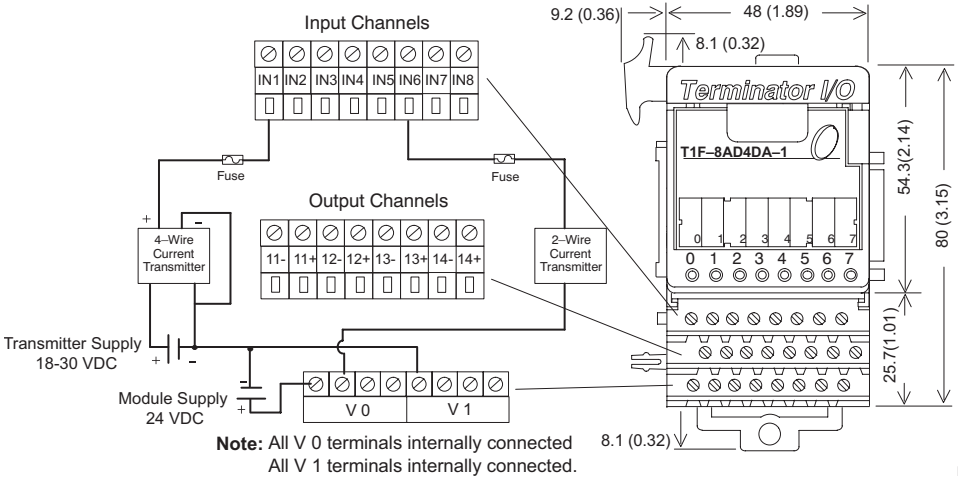
T1F-8AD4DA-1 8 Channel Current Analog Input / 4 Channel Current Analog Output

Input Channel Specifications	
Number of Channels	8, single ended (1 common)
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Input Ranges	0 - 20 mA, 4 - 20 mA, - 20 to 20 mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response Input active low-pass filter	- 3 db @ 100 Hz, - 20 db / decade
Input Resistance	250 Ω
Absolute Maximum Ratings	8V max. Input
Conversion Time	5 ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.18% @ 25° C 0.36% @ 60° C
Recommended Fuse	0.032 A, Series 217 Fast Acting

Input Range Resolution	
-20 to 20 mA	-8192 to 8191 counts
0 - 20 mA	0 - 8191 counts
4 - 20 mA	1638 - 8191 counts

Module General Specifications	
CPU Update Rate	12 channels per scan maximum
Base Power Required	75 mA @ 5 VDC
External Module Power Supply	21.6 - 26.4 VDC, 50 mA, class 2 (plus 20 mA per channel loop)
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	136 g

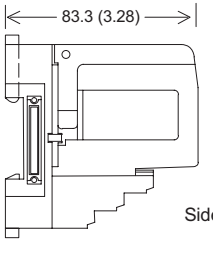
Input Wiring & Dimensions



Note: All V 0 terminals internally connected
All V 1 terminals internally connected.

mm (in.)

NOTE: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.

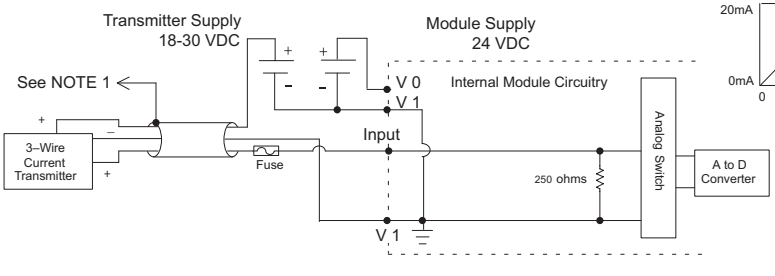


Side View

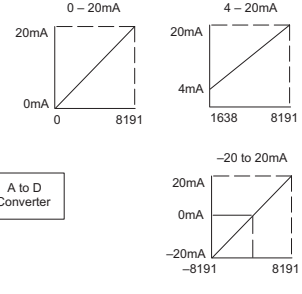
NOTES:

1. Shields should be grounded at the signal source.
2. More than one external power supply can be used, provided all the power supply commons are connected.
3. A Series 217, 0.032 A fast-acting fuse is recommended for 4–20 mA current loops.
4. If the power supply common of an external power supply is not connected to the 0V terminal on the module, then the output of the external transmitter must be isolated. To avoid “ground loop” errors, recommended 4–20 mA transmitter types are:
   – For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.
   – For 4 wire connections: Isolation between the input supply signal, the power supply and the 4–20 mA output.

Equivalent Input Circuit



Input Signal Ranges

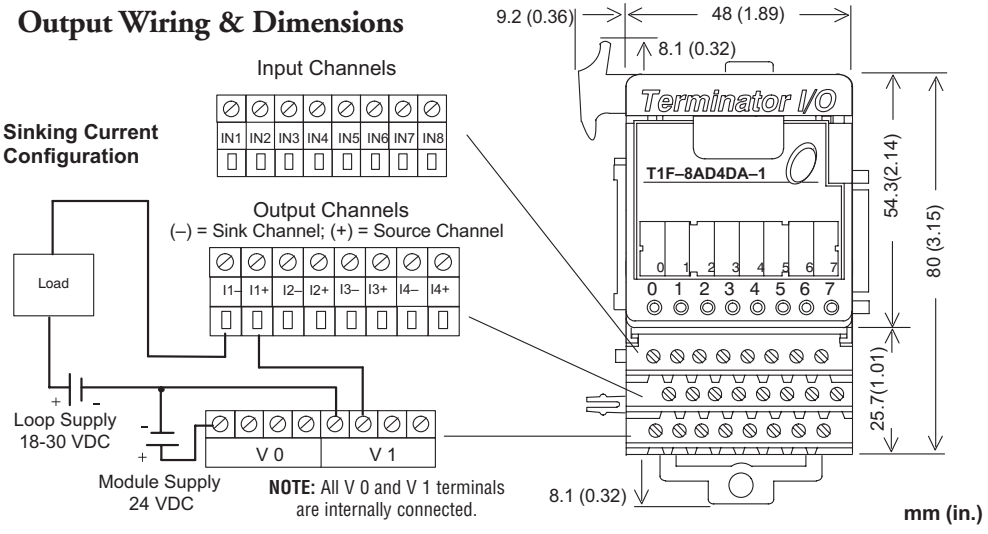


T1F-8AD4DA-1

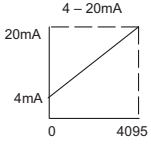
Output Channel Specifications	
Number of Channels	4, sink/source; individually configured by wiring
Output Points Required	128 discrete pts. or 4 dwords (d (double) word = 32 bit word) Network Interface dependent
Output Range	4 - 20 mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Maximum Loop Supply	30 VDC
Source Load (ohms) / Loop Power Supply	0 - 400 Ω / 18 - 30 V
Sink Load (ohm) / Loop Power Supply	0 - 600 Ω / 18 V, 0 - 900 Ω / 24 V, 0 - 1200 Ω / 30 V
Total Load (Sink plus Source)	600 Ω / 18 V, 900 Ω / 24 V, 1200 Ω / 30 V
Linearity Error (end to end)	+ / - 2 count maximum + / - 0.050% of full scale maximum
Conversion Settling Time	400 μs maximum full scale change
Full Scale Calibration Error (Note: source error depaends upon the load from source terminal to ground)	SINK: + / - 12 counts max. @ any load SOURCE: + / - 26 counts max. @ 400 Ω load + / - 18 counts max. @ 250 Ω load + / - 12 counts max. @ 125 Ω load
Offset Calibration Error	SINK: + / - 6 counts max. @ any load SOURCE: + / - 10 counts max. @ 400 Ω load + / - 8 counts max. @ 250 Ω load + / - 6 counts max. @ 125 Ω load
Max. Full Scale Inaccuracy (% of full scale); all errors included	SINK: (any load) 0.3% @ 25° C (any load) 0.5% @ 60° C SOURCE: 400 Ω load 0.63% @ 25° C 400 Ω load 0.83% @ 60° C 250 Ω load 0.44% @ 25° C 250 Ω load 0.64% @ 60° C 125 Ω load 0.30% @ 25° C 125 Ω load 0.50% @ 60° C

NOTE: *This module requires software setup via the Module Control Byte. Refer to Chapter 4.*

Output Wiring & Dimensions

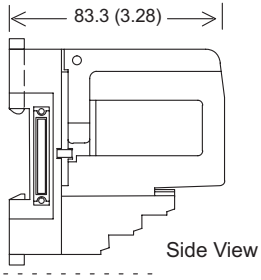


Output Signal Range

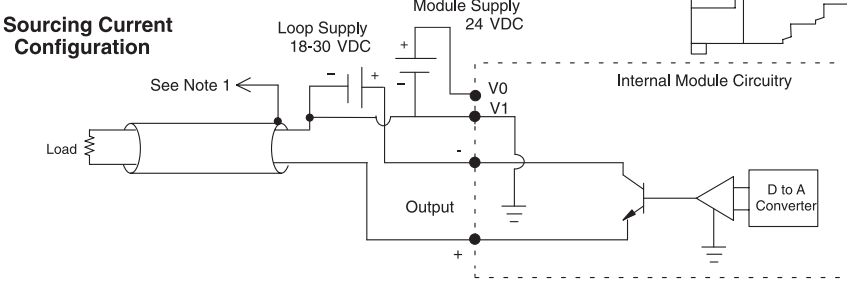


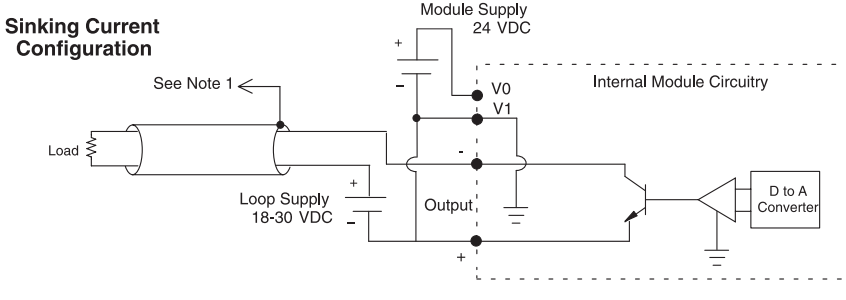
NOTES:

1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.
2. Unused current outputs should remain open (no connections) for minimum power consumption.



Equivalent Output Circuit





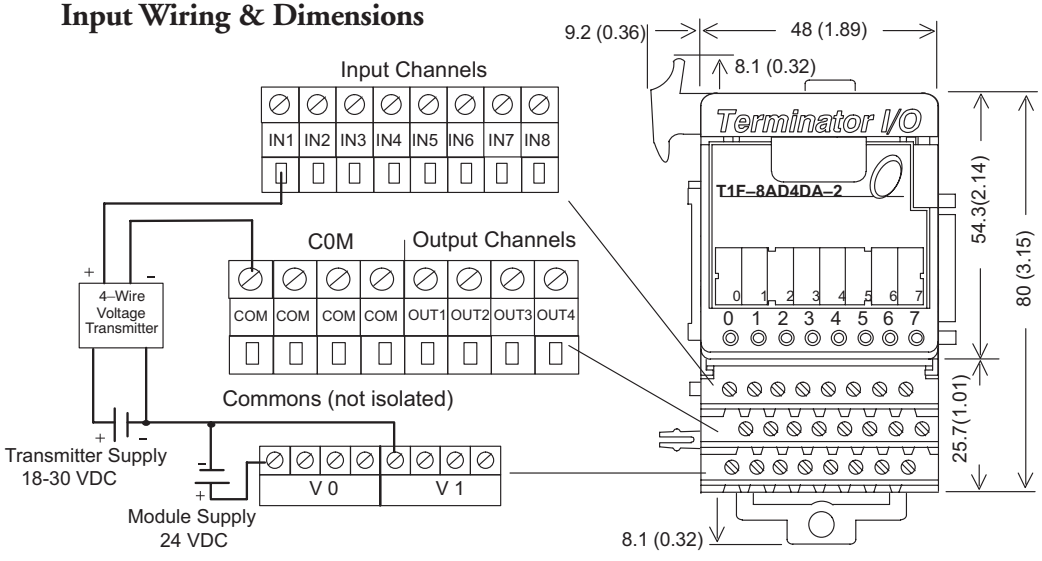
T1F-8AD4DA-2 8 Channel Voltage Analog Input / 4 Channel Voltage Analog Output

Input Channel Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3 db @ 500 Hz, - 20 db / decade
Input Resistance	200 KΩ min.
Absolute Maximum Ratings	Fault Protected Input, 130 V (rms) or 100 VDC
Conversion Time	5.5 ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25° C 0.26% @ 60° C
Master Update Rate	8 channels per scan maximum
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75 mA @ 5 VDC
External Module Power Supply	21.6 - 26.4 VDC, 70 mA, class 2
External Transmitter Power Supply	18 - 30 VDC, 70 mA, class 2

Input Range Resolution	
0 - 5 V	0 - 4095 counts
0 - 10 V	0 - 8191 counts
+ / - 5 V	- 4095 to 4095 counts
+ / - 10 V	- 8192 to 8191 counts

NOTE: *Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.*

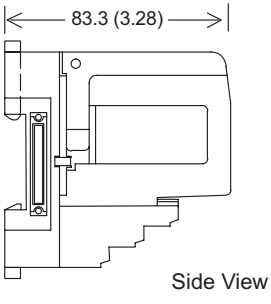
Input Wiring & Dimensions



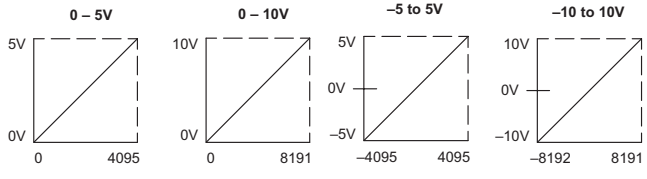
mm (in.)

NOTES:

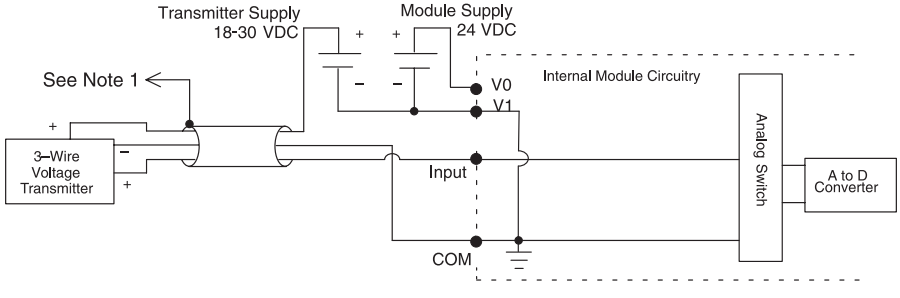
1. V1 terminals are internally connected to Commons.
2. Shields should be grounded at the signal source.
3. Unused inputs should be connected to Common (0 VDC).
4. More than one external power supply can be used, provided all the power supply commons are connected.



Input Signal Ranges



Equivalent Input Circuit

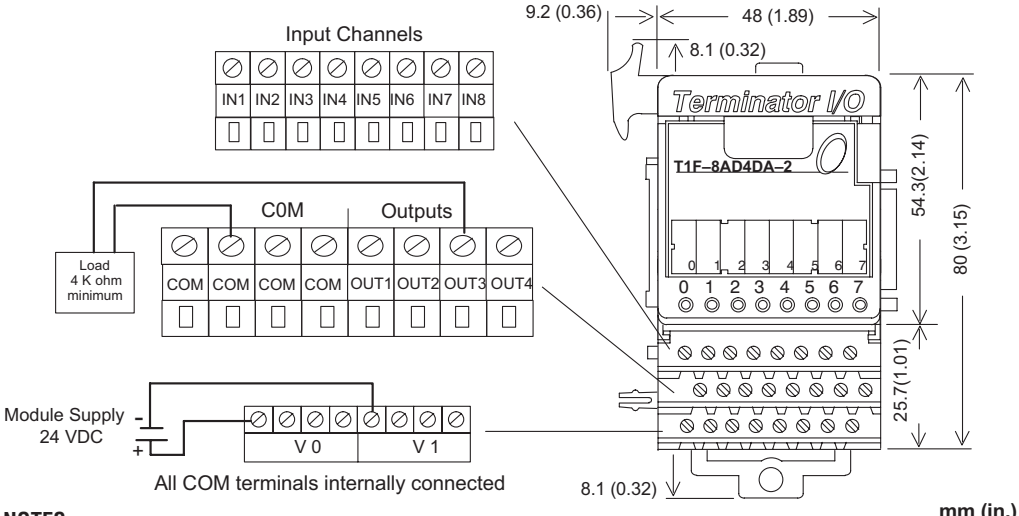


T1F-8AD4DA-2

Output Channel Specifications	
Number of Channels	4
Output Ranges	0 - 5 V, 0 - 10 V, + / - 5 V, + / - 10 V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4 KΩ minimum
Load Capacitance	0.01 μF maximum
Linearity Error (end to end)	+ / - 2 count maximum + / - 0.050% of full scale maximum
Conversion Settling Time	300 μs maximum full scale change
Full Scale Calibration Error	+ / - 12 counts maximum
Accuracy vs. Temperature	+ / - 50 ppm/ ° C; full scale calibration change
Offset Calibration Error	10 V ranges: + / - 5 counts 5 V ranges: + / - 9 counts
Max. Full Scale Inaccuracy (% of full scale); all errors and temperature drift included	10 V ranges: + / - 0.2% @ 25° C + / - 0.4% @ 60° C 5 V ranges: + / - 0.3% @ 25° C + / - 0.5% @ 60° C
Master Update Rate	4 channels per scan max.
Output Points Required	128 discrete pts. or 4 Dwords (32-bit words) (Network Interface Dependent)

Module General Specifications	
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	- 20° to 70° C (- 4° to 158° F)
Accuracy vs. Temperature	+ / - 50 ppm / ° C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	136 g

Output Wiring & Dimensions



mm (in.)

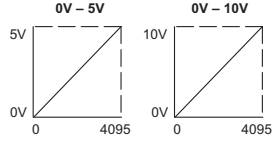
NOTES:

1. V 1 terminals are internally connected.
2. Shields should be connected to the 0 V terminal of the module at the 0 V terminal of the power supply.
3. Unused voltage outputs should remain open (no connections) for minimum power consumption.

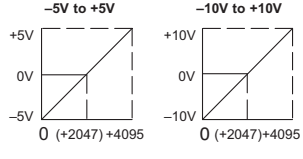
Output Range Resolution:

0 – 5V	0 – 4095
0 to 10V	0 – 4095
+ / – 5V	0 – 4095
+ / – 10V	0 – 4095

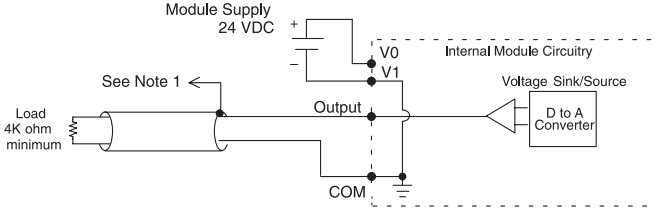
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



NOTE: *The output channels require software setup via the Module Control Byte. Refer to Chapter 4.*

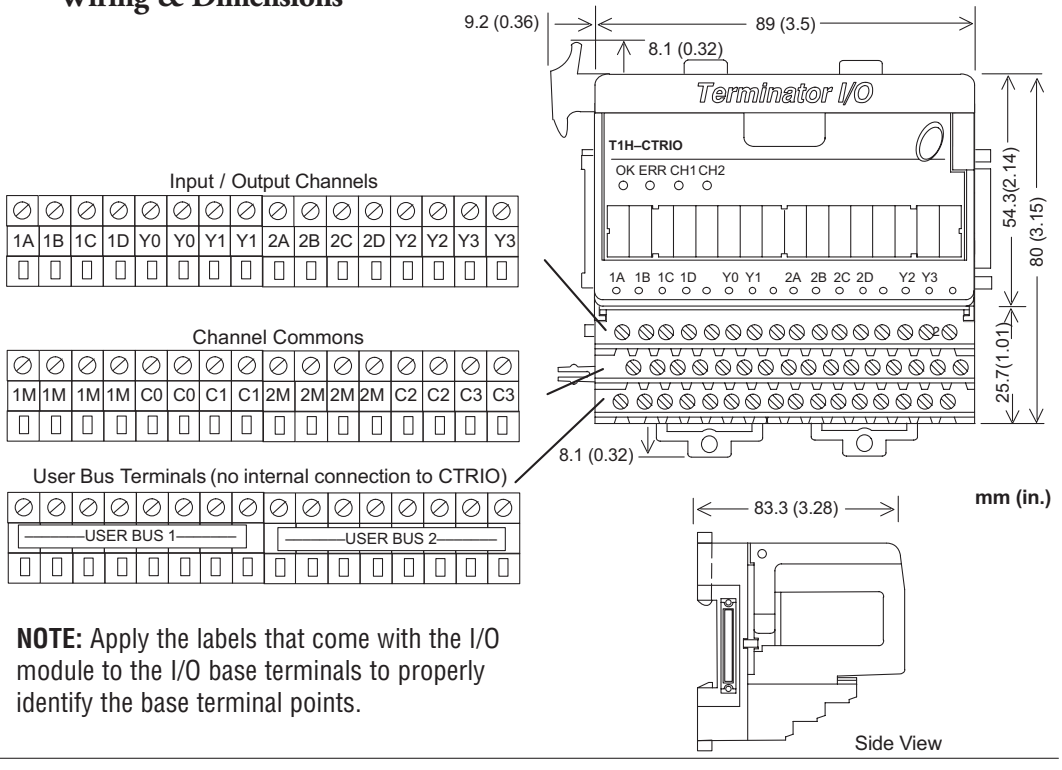
T1H-CTRIO Counter I/O Module

Input Specifications	
Input	8 pts. (2 isolated channels / 4 pts. each channel), sink / source, 100 KHz maximum; See Input Resources Table for available Input Function options.
Minimum Pulse Width	5 μs
Input Voltage Range	9 - 30 VDC
Maximum Voltage	30 VDC
Input Voltage Protection	Zener clamped at 33 VDC
Rated Input Current	8 mA typical, 12 mA maximum
Minimum ON Voltage	9.0 VDC
Maximum OFF Voltage	2.0 VDC
Minimum ON Current	5.0 mA @ 9.0 VDC
Maximum OFF Current	2.0 mA
OFF to ON Response	< 3.0 μs
ON to OFF Response	< 3.0 μs

Output Specifications	
Outputs	4 pts., independently isolated, sink / source (FET Outputs); See Output Resources Table for available Output Function options.
Voltage Range	5 - 36 VDC
Maximum Voltage	36 VDC
Output Clamp Voltage	60 VDC
Maximum Load Current	1.0 A
Maximum Leakage Current	100 μA
Inrush Current	5.0 A for 20 ms
OFF to ON Response	< 3.0 μs
ON to OFF Response	< 3.0 μs
ON State Voltage Drop	< 0.3 V
External Power Supply	For loop power only, is not required for internal module function.
Overcurrent Protection	15 A maximum
Base Power Required	400 mA @ 5 VDC
Thermal Shutdown	Tjunction = 150° C
Overtemperature Reset	Tjunction = 130° C
Duty Cycle Range	1% to 99% in 1% increments
Configurable Presets a) single b) multiple	a) Each output can be assigned one preset, or b) Each output can be assigned one table of presets, one table can contain max. 128 presets, max. predefined tables = 255

General Specifications	
Module Type	Intelligent
Modules Per Base	Limited only by power consumption
I/O Points Used	None, I/O map directly in PLC V-memory or PC control access
Field Wiring Connector	Standard removable terminal block
Internal Power Consumption	400 mA Max at +5V from Base Power Supply, Maximum of 6 Watts (All I/O in ON State at Max Voltage/Current)
Operating Environment	32°F to 140°F (0°C to 60°C), Humidity (non-condensing) 5% to 95%
Isolation	2500 V I/O to Logic, 1000 V among Input Channels and All Outputs

Wiring & Dimensions


Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
User Bus Terminals (no internal connection to CTRIO)
USER BUS 1
USER BUS 2
9.2 (0.36)
89 (3.5)
8.1 (0.32)
Terminator I/O
T1H–CTRIO
OK ERR CH1 CH2
1A 1B 1C 1D Y0 Y1 2A 2B 2C 2D Y2 Y3
54.3(2.14)
80 (3.15)
25.7(1.01)
8.1 (0.32)
mm (in.)
83.3 (3.28)
Side View

NOTE: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.

LED Indicators

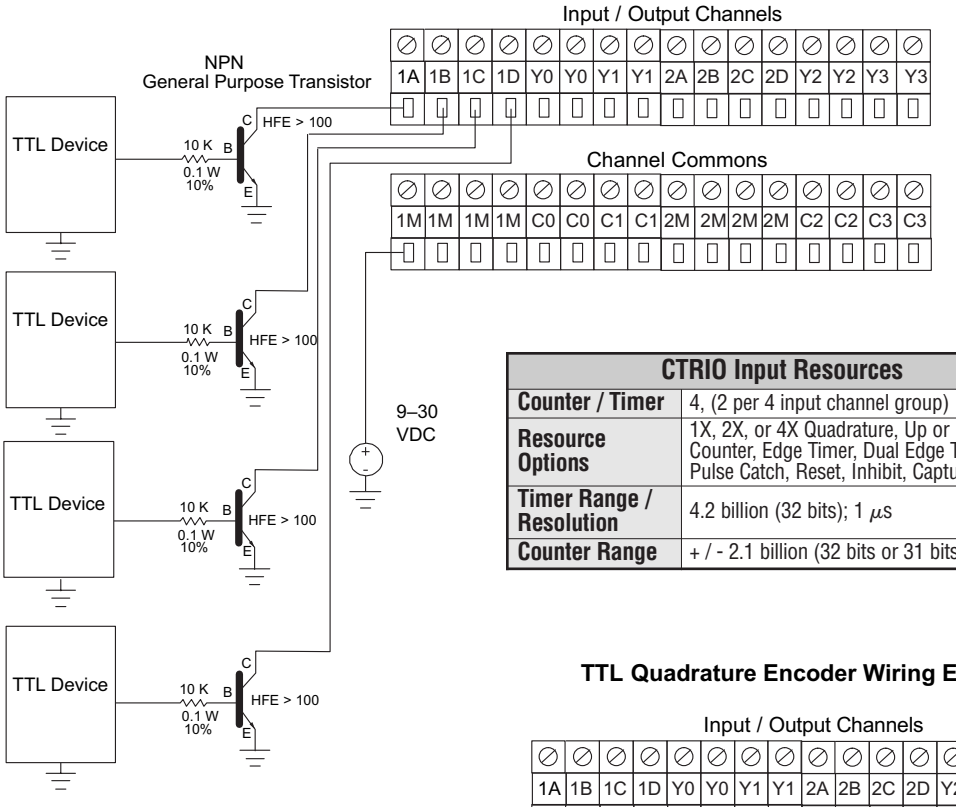
LED Diagnostic Definitions		
OK	**ERR**	**Description**
ON	OFF	All is well - Run Mode
ON	ON	Hardware Failure
Blinking	Blinking	Boot Mode - Use for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self - diagnostic Failure
OFF	ON	Module Error due to Watchdog Timeout
OFF	OFF	No Power to Module

LED Descriptions	
OK	Module OK
ERR	User Program Error
CH1	Channel 1 Status
CH2	Channel 2 Status
1A - 1D	Channel 1 A-D Status
2A - 2D	Channel 2 A-D Status
Y0 - Y3	Output Status

More LED Diagnostics Definitions	
CH1	Blinks when Channel 1 Function 1 is counting or timing.
CH2	Blinks when Channel 2 Function 1 is counting or timing.
Y0 - Y3	Follows actual output state; ON = output is passing current.

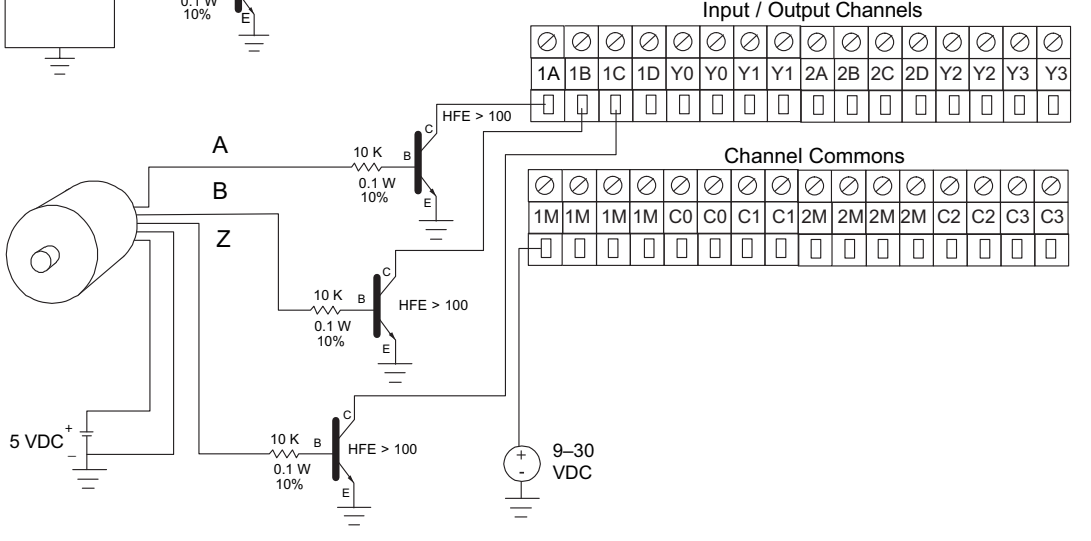
T1H-CTRIO Input Wiring Diagrams

TTL Input Wiring Example


Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
NPN
General Purpose Transistor
TTL Device
10 K
0.1 W
10%
HFE > 100
9–30
VDC

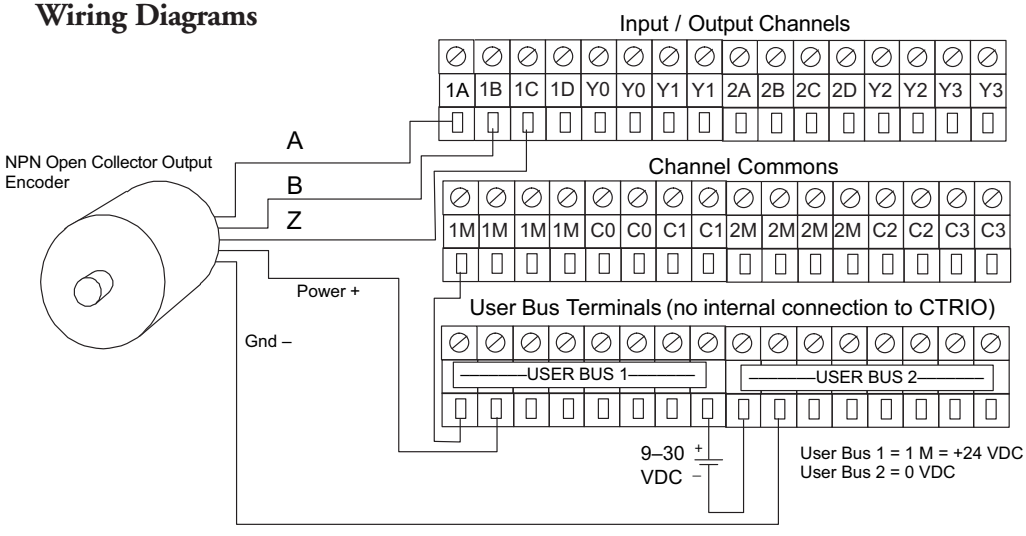
CTRIO Input Resources	
Counter / Timer	4, (2 per 4 input channel group)
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Pulse Catch, Reset, Inhibit, Capture
Timer Range / Resolution	4.2 billion (32 bits); 1 μs
Counter Range	+ / - 2.1 billion (32 bits or 31 bits + sign bit)

TTL Quadrature Encoder Wiring Example

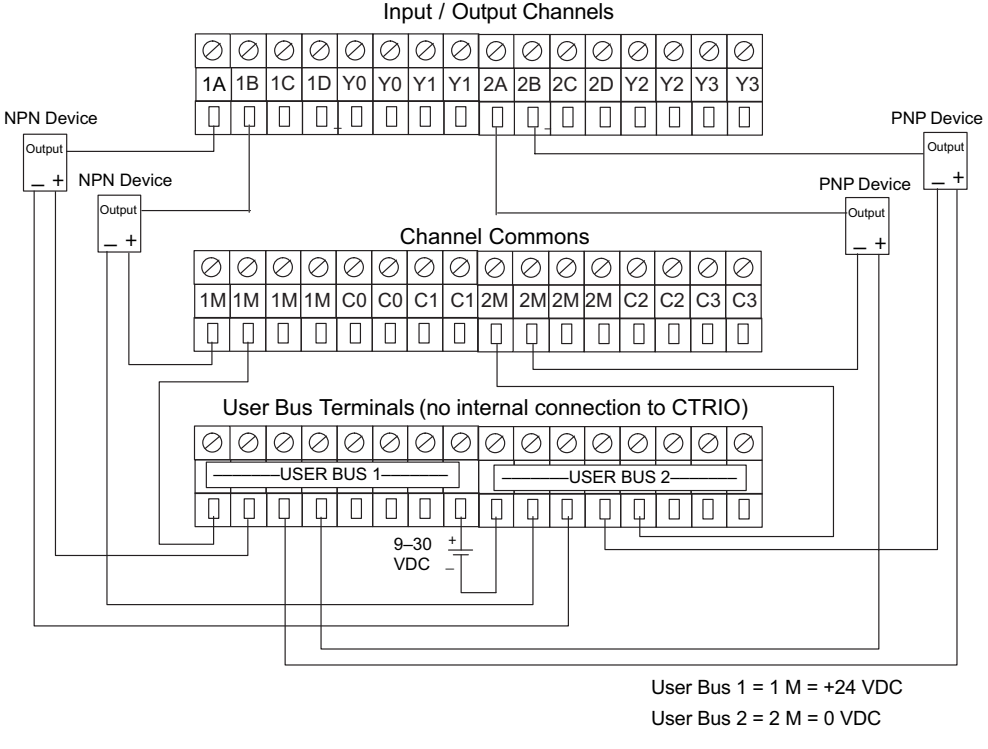


T1H-CTRIO Input Wiring Diagrams

Quadrature Encoder Wiring Example

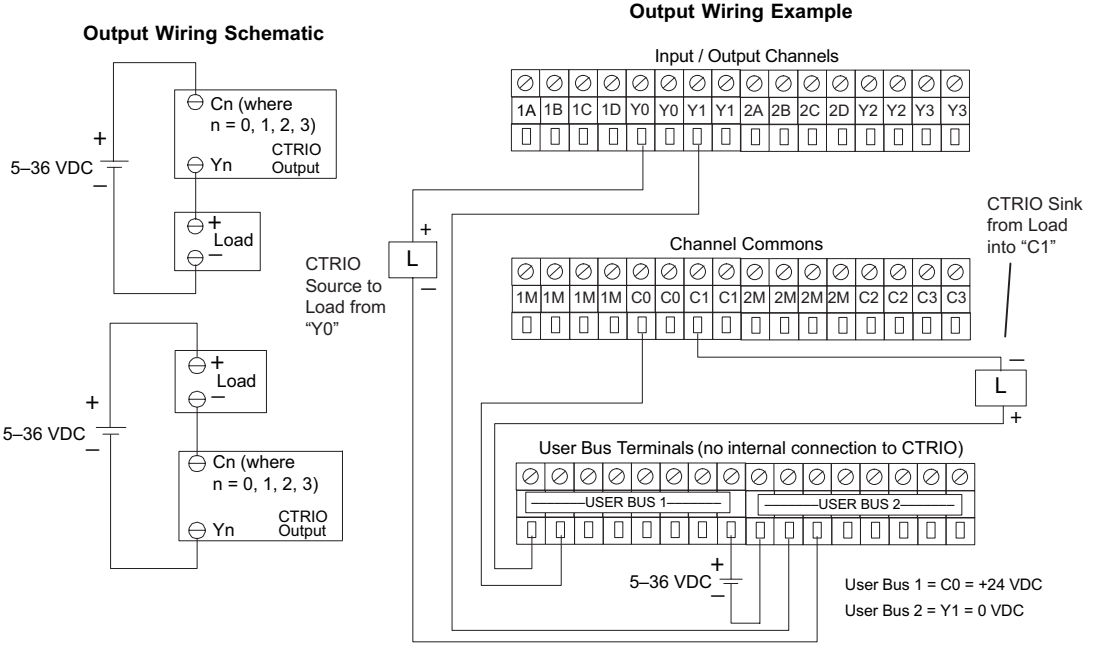

Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
NPN Open Collector Output Encoder
A
B
Z
Power +
Gnd –
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
User Bus Terminals (no internal connection to CTRIO)
USER BUS 1
USER BUS 2
9–30 VDC
User Bus 1 = 1 M = +24 VDC
User Bus 2 = 0 VDC

Input Wiring Example


Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
NPN Device
Output
PNP Device
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
User Bus Terminals (no internal connection to CTRIO)
USER BUS 1
USER BUS 2
9–30 VDC
User Bus 1 = 1 M = +24 VDC
User Bus 2 = 2 M = 0 VDC

T1H-CTRIO Output Wiring Diagrams

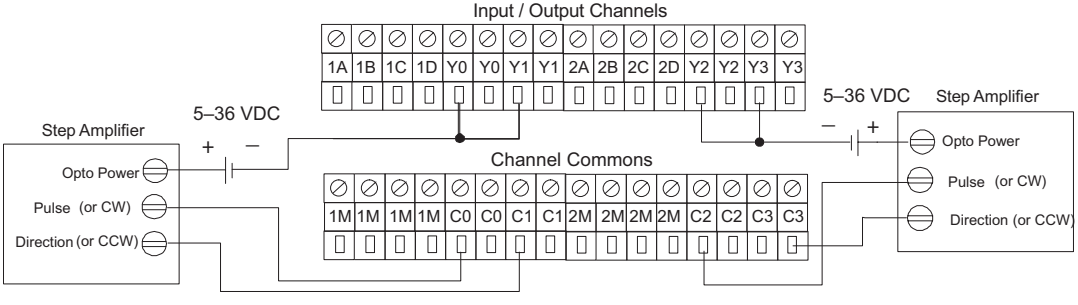
The module has 4 optically isolated output points (pts. Y0 - Y3 with isolated commons C0 - C3, respectively). The outputs must be wired so positive current flows into Cn terminal and then out of the Yn terminal.


Output Wiring Schematic
Cn (where n = 0, 1, 2, 3)
CTRIO Output
Yn
5–36 VDC
Load
Output Wiring Example
Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
CTRIO Source to Load from "Y0"
CTRIO Sink from Load into "C1"
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
User Bus Terminals (no internal connection to CTRIO)
USER BUS 1
USER BUS 2
User Bus 1 = C0 = +24 VDC
User Bus 2 = Y1 = 0 VDC

T1H-CTRIO Output Wiring Diagrams

The stepper wiring example assumes the Step Amplifier interface to be opto-coupler LEDs (common anodes at the "OPTO Power" terminal) with internal current limiting resistors. This is a standard method, but you must consult your stepper amplifier documentation to ensure that this method is applicable.

Stepper / Servo Drive Wiring Example


Input / Output Channels
1A 1B 1C 1D Y0 Y0 Y1 Y1 2A 2B 2C 2D Y2 Y2 Y3 Y3
5–36 VDC
Step Amplifier
+ –
Opto Power
Pulse (or CW)
Direction (or CCW)
Channel Commons
1M 1M 1M 1M C0 C0 C1 C1 2M 2M 2M 2M C2 C2 C3 C3
5–36 VDC
Step Amplifier
– +
Opto Power
Pulse (or CW)
Direction (or CCW)

CTRIO Output Resources	
Pulse outputs / Discrete outputs	Pulse outputs: 2 Channels (2 outputs per channel) Discrete outputs: 4 pts.
Resource Options	Pulse outputs: pulse / direction or CW / CCW. Profiles: Trapezoid, S-Curve, Symmetrical S-Curve, Dynamic Positioning, DynamicVelocity, Home Search, Velocity Mode, Run to Limit Mode, and Run to Position Mode. Discrete Outputs: 4 configurable for set, reset, pulse on, pulse off, toggle, and reset count function (assigned to to respond to Timer / Counter functions). RawMode: Direct access to output from user program.
Target Position Range	+ / - 2.1 billion (32 bits or 31 bits + sign bit)

T1K-08B(-1) I/O Module Base

Specifications		
Specification	**T1K-08B**	**T1K-08B-1**
Terminal Type	screw type	spring clamp type
Recommended Torque	1.77 - 3.54 lb-inch (0.2 - 0.4 Nm)	-
Recommended Screwdriver Blade Size	0.02 in. X 0.125 in. (0.5 mm X 3.0 mm)	Push in on clamp using screwdriver blade size: 0.016 X 0.79 in. to 0.032 X 0.16 in. (0.4 mm X 2 mm to 0.8 mm X 4 mm)
Wire Gauge Size	solid conductor: 25 - 12 AWG stranded conductor: 26 - 12 AWG*	solid conductor: 25 - 14 AWG stranded conductor: 26 - 14 AWG*
Weight	135 g	125 g

*Twist conductors before inserting into gate.

T1K-16B(-) I/O Module Base

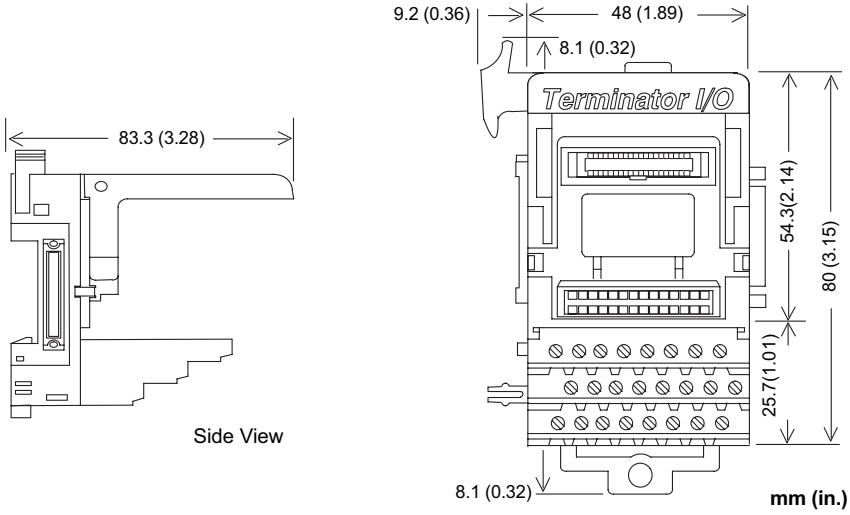
Specifications		
Specification	**T1K-16B**	**T1K-16B-1**
Terminal Type	screw type	spring clamp type
Recommended Torque	1.77 - 3.54 lb-inch (0.2 - 0.4 Nm)	-
Recommended Screwdriver Blade Size	0.02 in. X 0.125 in. (0.5 mm X 3.0 mm)	Push in on clamp using screwdriver blade size: 0.016 X 0.79 in. to 0.032 X 0.16 in. (0.4 mm X 2 mm to 0.8 mm X 4 mm)
Wire Gauge Size	solid conductor: 25 - 12 AWG stranded conductor: 26 - 12 AWG*	solid conductor: 25 - 14 AWG stranded conductor: 26 - 14 AWG*
Weight	220 g	210 g

*Twist conductors before inserting into gate.

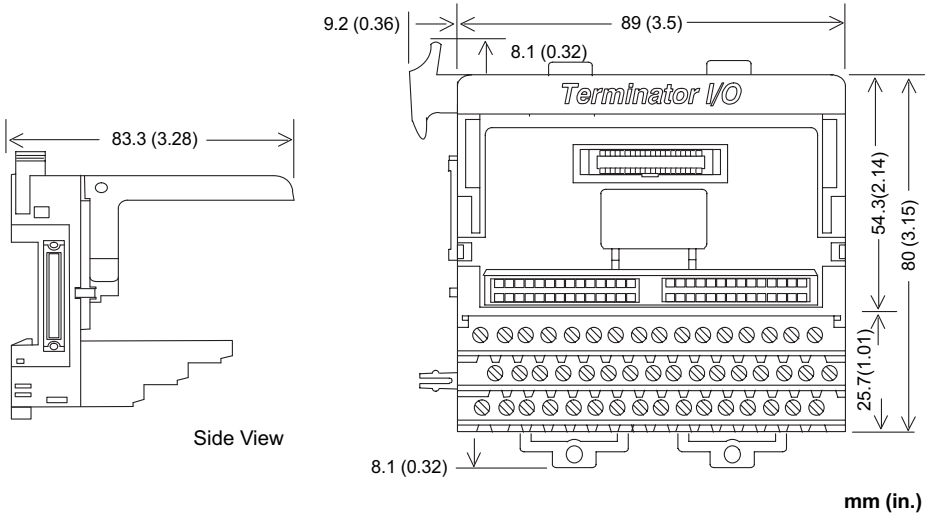
Environmental Specifications	
Ambient Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 516.2
Voltage Withstand	1500 VAC, 1 minute
Insulation Resistance	500 VDC, 10 MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μs, 1000V FCC class A RFI (144 MHz, 430 MHz 10W, 10 cm)
Agency Approvals	UL, CE, FCC class A

Dimensions

T1K–08B, T1K–08B–1



T1K–16B, T1K–16B–1

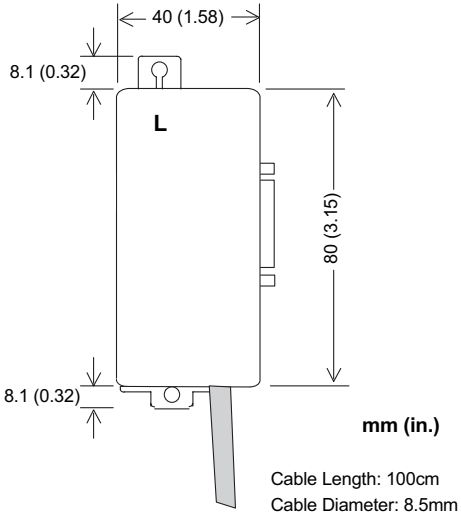


T1K-10CBL, T1K-10CBL-1 Expansion Cable

Specifications

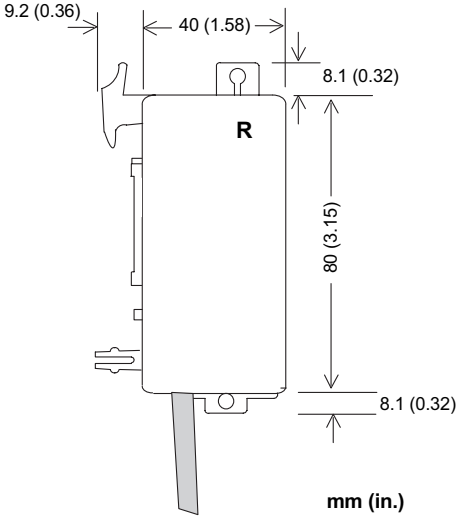
Specifications			
Specification		**T1K-10CBL**	**T1K-10CBL-1**
Cable Length		100 cm (3.28 ft.)	
Cable Diameter		8.5 mm	
Shielding		None	
Temperature Range		-25° C to 80° C (-13° F to 176° F)	
Jacket Material		PVC	
Auxiliary 24 VDC Cable	Cable Diameter	-	2 cables used: 1.42 mm each
	Insulation Voltage	-	2000 VAC / 1 minute

Dimensions

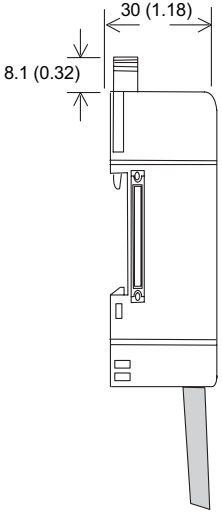


mm (in.)

Cable Length: 100cm
Cable Diameter: 8.5mm



mm (in.)



mm (in.)

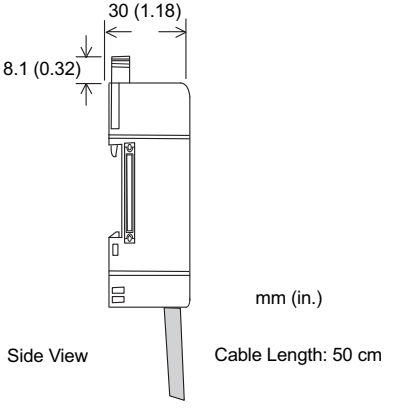
T1K-5CBL-LL(-1) Expansion Cable

Specifications			
Specification		**T1K-05CBL-LL**	**T1K-05CBL-1-LL-1**
Cable Description		Left-to-left Side Expansion Cable	
Cable Length		50 cm (1.64 ft.)	
Cable Diameter		8.5 mm	
Shielding		None	
Temperature Range		-25° C to 80° C (-13° F to 176° F)	
Jacket Material		PVC	
Auxiliary 24 VDC Cable	Cable Diameter	-	Two 1.42 mm cables used in a 6 mm sheath
	Insulation Voltage	-	2000 VAC / 1 minute

T1K-5CBL-RR(-1) Expansion Cable

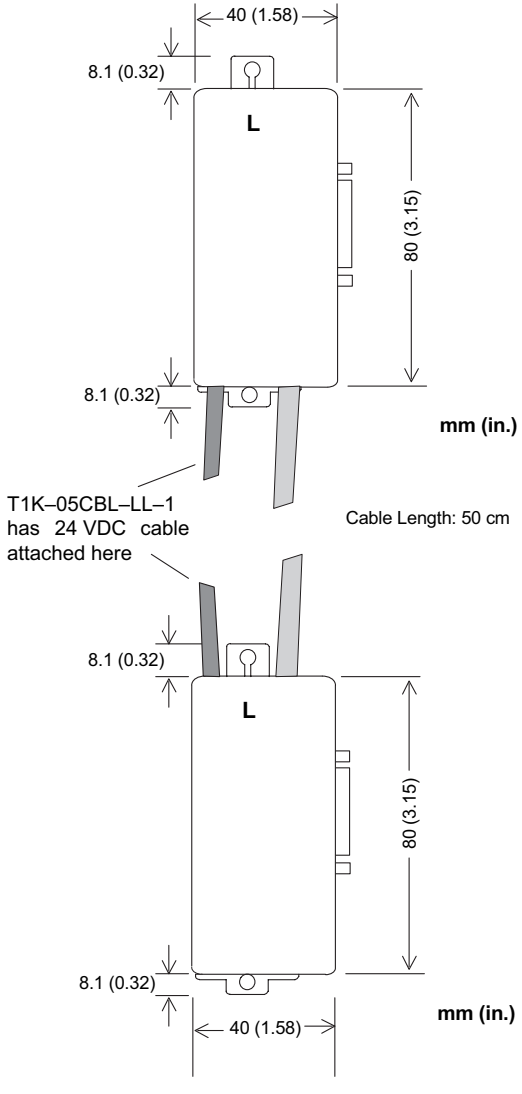
Specifications			
Specification		**T1K-05CBL-RR**	**T1K-05CBL-1-RR-1**
Cable Description		Right-to-right Side Expansion Cable	
Cable Length		50 cm (1.64 ft.)	
Cable Diameter		8.5 mm	
Shielding		None	
Temperature Range		-25° C to 80° C (-13° F to 176° F)	
Jacket Material		PVC	
Auxiliary 24 VDC Cable	Cable Diameter	-	Two 1.42 mm cables used in a 6 mm sheath
	Insulation Voltage	-	2000 VAC / 1 minute

NOTE: *Please refer to Chapter 2 for application examples using the different types of expansion cables that are available.*

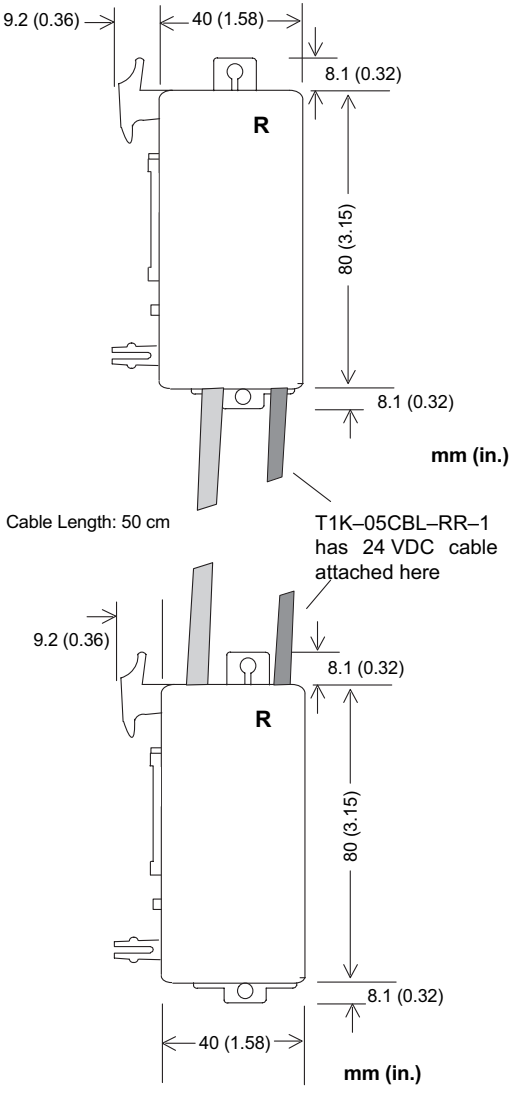


Dimensions

T1K–05CBL–LL(–1)



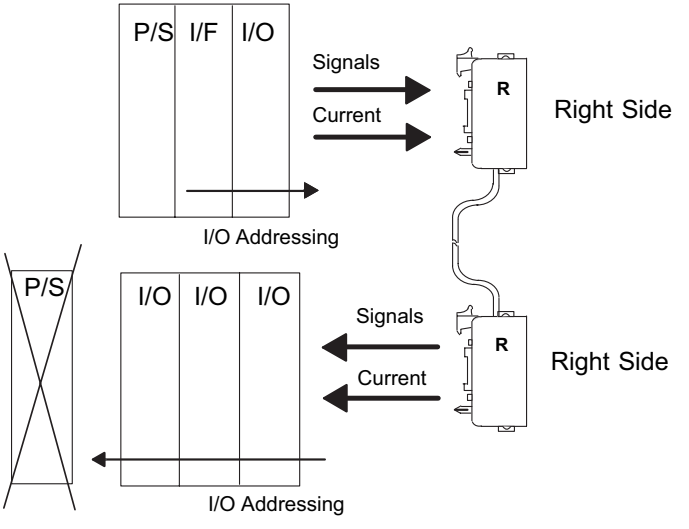
T1K–05CBL–RR(–1)



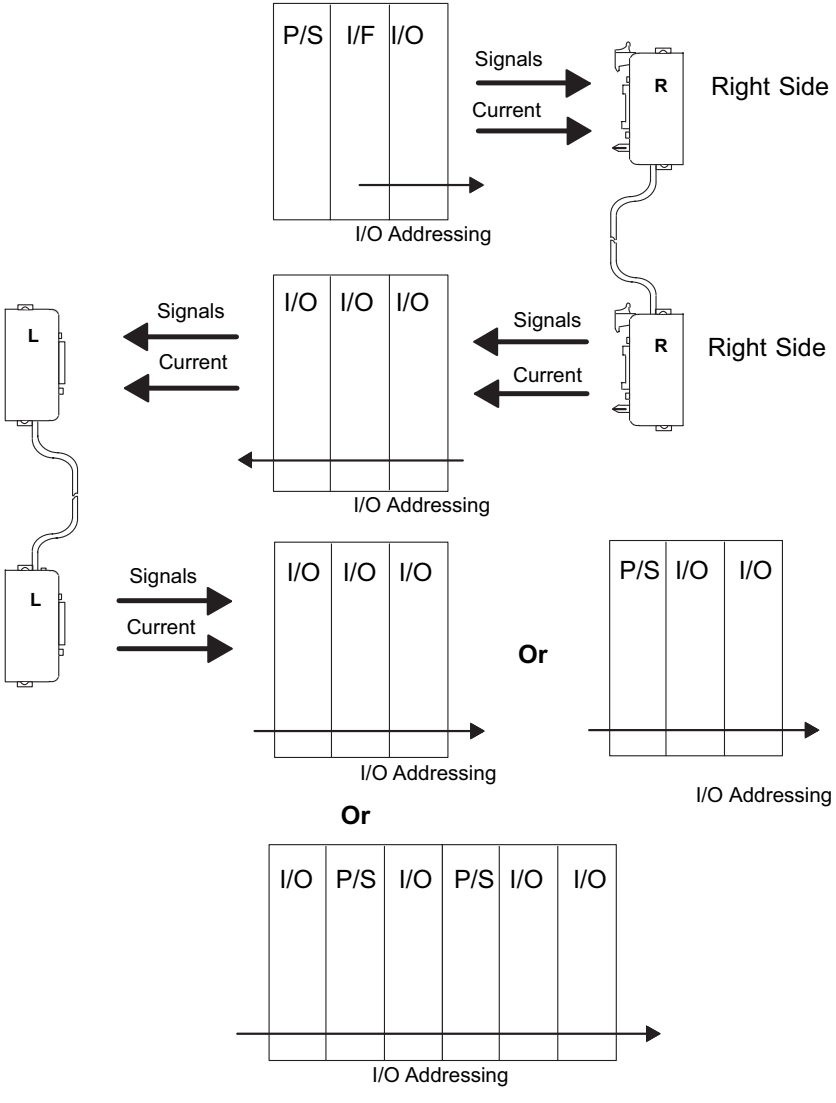
Cable Connection Examples

This is an example using the T1K-05CBL-RR (T1K-05CBL-RR-1) cable. It is always connected from the right side to the right side.

NOTE: *Do not put a power supply (P/S) on the expansion row in this example.*

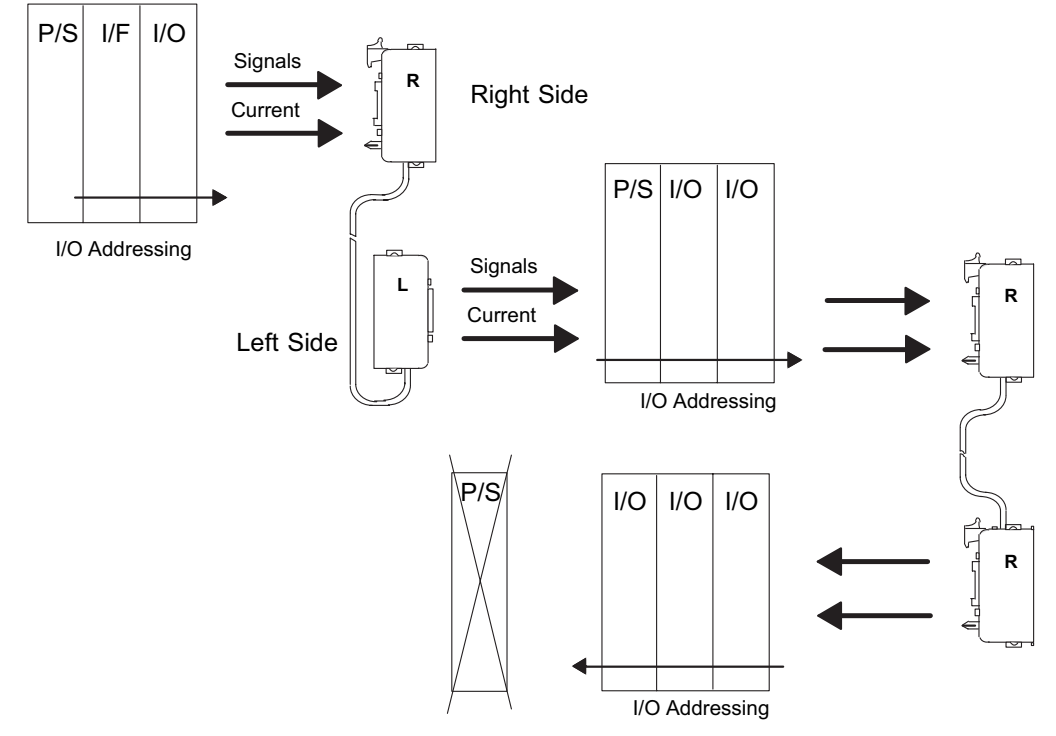


When another expansion row is added to the example on the left, a T1K-05CBL-LL (T1K-05CBL-LL-1) cable is used. It is always connected from the left side to the left side, but it is never used as the first cable.



NOTE: *Another P/S can be put on the expansion row that is connected through the T1K-05CBL-LL cable.*

In this example, a T1K-10CBL cable is used to connect the local base I/O to an expansion row that has a power supply (P/S) installed in the first position on the row. The next expansion row, without a P/S, is connected using a T1K-05CBL-RR-1 cable.



NOTE: *Do not put a power supply (P/S) on the last expansion row in this example.*